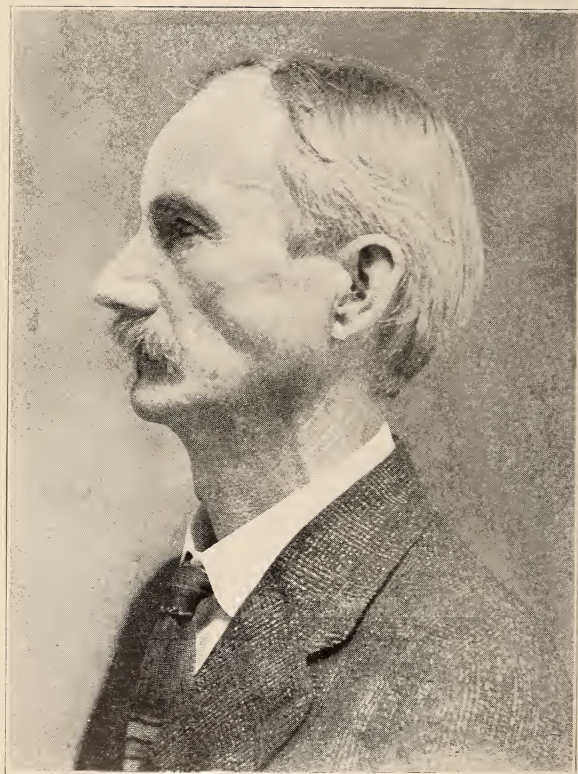






TO THE MOON AND BACK
IN NINETY DAYS



JOHN YOUNG BROWN

TO THE MOON AND BACK IN NINETY DAYS

A THRILLING NARRATIVE OF BLENDED
SCIENCE AND ADVENTURE

BY
JOHN YOUNG BROWN, A. B.

“Heaven’s ebon vault
Studded with stars unutterably bright,
Through which the moon’s unclouded grandeur rolls,
Seems like a canopy which love has spread
To curtain her sleeping world”

Shelley’s Queen Mab. IV.

1922

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226, Nov. 5, 1918

To
My Pupils
Whose Appreciative Sympathy
Has Made of Our Schoolroom Days
a Delightful Experience

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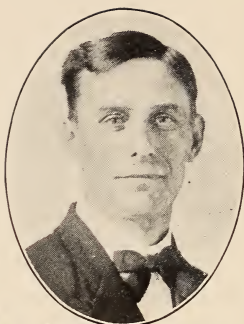
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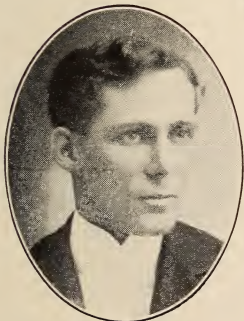
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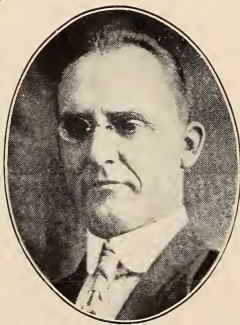
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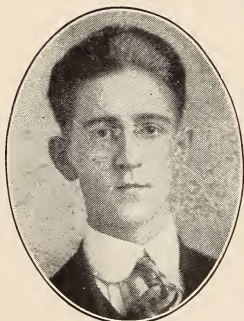
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VANDERLIP



Mr. FRANK GILMAN
WAITE



Prof. HANSON GOODWIN
BRUNOR



Mr. WARREN NEWELL
SHIPLEY



Prof. BURWELL ESTEN
RIDER

PREFACE.

It is well at times for one to turn his thoughts from the strenuity of business, from the fires of ambition, and from the horrors of war, to the more quiet fields of science.

For thus freeing the mind occasionally from such exciting cares with their unwholesome effects, perhaps no other branch of study is so well adapted as astronomy, the prosecution of which is, indeed, a fascinating pursuit, elevating the mind, ennobling the aspirations, and dispelling the distractions of mundane existence.

The moon, being the nearest to us of all the heavenly bodies, has long been the favorite study of astronomers who, by training their telescopes upon it, have been able to photograph many of its physical features and to map the surface of its visible hemisphere, and thereby to give us a mass of information in regard to the conditions thereon. But this knowledge is practically confined to a limited few whose special interest in, and easy access to, the facts of astronomy bring them at once and directly in touch with such information.

To popularize this branch of knowledge, to make it the common possession of all, is the author's object. He hopes that in this story, "TO THE MOON AND BACK IN NINETY DAYS," in which he has been careful to record the exact finding of selenographical research, he has so incorporated the spirit of adventure as to interest the young and to lead them on to the study of astronomy in general.

In conclusion the author expresses his sincere thanks to Prof. E. B. Frost, director of the Yerkes Observatory, who kindly consented for him to use many of the plates found in this work; to Profs. H. W. Davis and S. Hicks of Providence, Ky., who carefully read the manuscript, offered important corrections, and made valuable suggestions for improvement; and to others for important aid which they have in various ways kindly rendered.

Providence, Kentucky,
June 7, 1917.

JOHN Y. BROWN.

PROLOGUE.

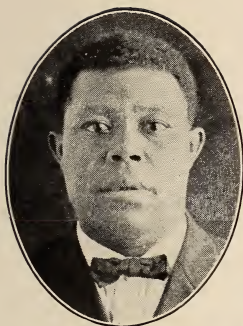
It is not for all of us to realize our fondest hope except in the confident assurance of its worthy purpose. But faithful labor in the performance of a helpful work carries its own reward, and recognition by our fellows but confirms the sincerity of our motives.

So in the death of the author of this book so shortly prior to its publication, a life-goal was barely missed, and yet he felt a supreme joy in the assurance of his grateful friends and pupils that the manuscript would be published.

The far-reaching influence of the work and character of Prof. Brown bears eloquent tribute to his life, and this book, dedicated to those who loved him so well, will be a lasting monument to his memory. Characteristic of his modest and unassuming manner, he faced the end with these words: "The only memorial I wish is a sand stone at the head of my grave and one of my books in the home of each of my pupils."

Then let us take up this volume with fitting reverence and treasure it as a rare token of loving service and unselfish devotion—consistent virtues of an unusual life.

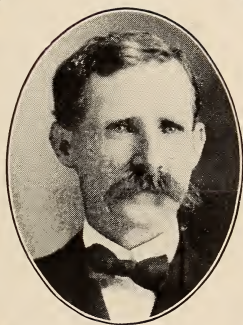
ONE OF HIS PUPILS.



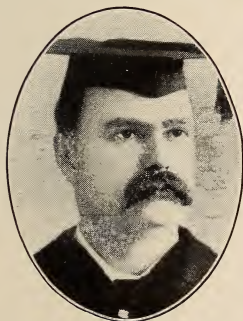
DICK PROWTY



Prof. CHARLES ULRIC
THORSEN



Prof. DANIEL CROWLEY
MONAHAN



Prof. PURDY WARFORD
KNOWLTON



Prof. GEORGE HUNDLEY
PURNELL

PUBLISHER'S NOTE.

The author of this Narrative made no pretensions to a literary career. His life work was in the school room, teaching young men and young women, in whose hearts his sympathy and kindness inspired respect and love.

Many of his pupils are now filling positions of usefulness and honor and attribute their success in no small measure to the time spent under his instruction. Some, indeed, say they owe all that they are to him.

It was for his pupils especially that he wrote this "Narrative of Blended Science and Adventure," and to them he dedicated the book. One of his last expressed wishes was that his only memorial might be, "a sand stone at the head of his grave and one of his books in the home of each of his pupils."

This story is different from anything ever written on the subject. It is not the result of a wild, unbridled imagination, relating things contrary to reason and utterly incapable of scientific adjustment as have been some books on trips to the moon. On the contrary its incidents are so constructed as to seem not only reasonable but probable and its scientific statements are reliable and recent.

Any one disposed to criticise this work should remember that the author died before his book went to the press, and did not have the opportunity of reading the proof sheets and making such corrections as he might have deemed essential. But, with whatever faults it may possess, the publishers feel that it will provide entertainment and instruction to multitudes of people, old as well as young, besides the thousands of his former pupils.

H. W. D.

CHAPTER I

A GLIMPSE AT THE SOLAR SYSTEM AND THE STELLAR UNIVERSE

The heavenly bodies are divided into four distinct classes—planets, comets, meteors, and fixed stars.

Planets are dense, opaque bodies, globular in form, which shine by reflecting the light of the sun. They obey the law of gravitation, revolve around the sun in various periods of time, in elliptical paths not differing much from the circle, and are periodic in their revolutions. Their orbits extend east and west around the celestial sphere, are almost parallel with one another and the ecliptic, and are confined within the limits of the zodiac. Of this class of heavenly bodies there are believed to be more than one thousand.

Comets are light, luminous bodies, without permanent form, which shine by their own light intensified by that of the sun. They are divided into three classes distinguished from one another according as they revolve in elliptical paths, pursue parabolic curves, or move along hyperbolic curves. They obey the law of gravitation and revolve around the sun; and these that belong to the first order are periodic in their revolu-

tions, while those that belong to the second and third groups visit the sun once only, and then launch themselves into the profound depths of space seeking other suns which they in turn will, no doubt, abandon as they do our own. Comets are very swift in their flight, and take on long fiery trains as they approach their perihelion distances. Their orbits are not confined to the zodiac, like those of the planets, but extend through the heavens in almost every conceivable direction. Of this class of heavenly bodies there are, according to the most reliable living authorities, no less than seventeen million and five hundred thousand within the solar system.

Meteors are small, dense, luminous bodies and have a globular form and a sensible diameter. They frequently pass over a great extent of country and are seen for several seconds. Some leave behind them a train of glowing sparks, and others explode with reports like the discharge of artillery—the pieces either continuing along their course or falling to the earth as meteorites. Before these little wanderers of the sky come in contact with the earth and are converted into meteors by the resistance offered by the atmosphere, they are truly little worlds as hard and as dry as a cinder, which, like the earth, obey the law of gravitation, revolve around the sun in elliptical paths, and are periodic in their return. These little planets, whose diameters range from a magnitude of perhaps not more than one-half inch to that of several feet, and whose weights vary from a few ounces to several tons, are as numerous as the leaves on the trees or as the sands of the sea shore. According to the late Pro-



FIG. 1. THE PLANET SATURN.

Saturn is the only planet, so far as human knowledge extends, that is encircled by rings.

(Yerkes Observatory.)



FIG. 2. HALLEY'S COMET, MAY 29, 1910.

The plate was exposed for two hours. The observer kept the telescope constantly pointed on the comet, following its course among the stars, which caused the elongation of the star images. The tail of the comet, as shown on this plate, was about seven million miles long and composed of luminous vapors chiefly hydrocarbons.

(Yerkes Observatory.)

fessor Newton the number of these miniature heavenly bodies that pierce the earth's atmosphere and are converted into meteors daily is no less than four hundred million; yet their number does not seem to be diminishing in the smallest degree.

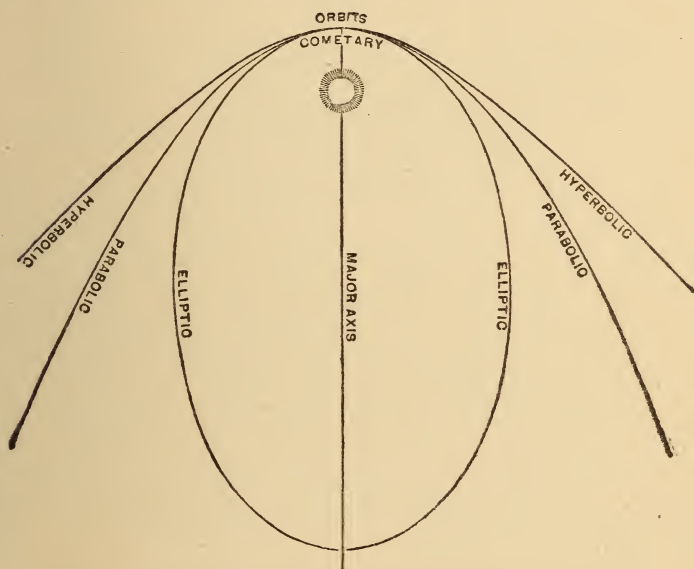


FIG. 3. THREE FORMS OF COMETARY ORBITS.

(Steele's Astronomy.)

The fixed stars, like the comets, are self-luminous and by far the largest, brightest, and most distant from us of all the heavenly bodies. They obey the law of gravitation and move very rapidly through the heavens, but for the short space of human life they appear to be fixed in the concave of the sky. Between them and us there is a vast chasm which no imagination can bridge—a distance so immense that figures

applied to it are meaningless. The number of this class of heavenly bodies is not reasonably limited.

The solar system, as a whole, is mainly comprised within the limits of the zodiac and consists of:

(1) The sun, which is classed with the fixed stars, and which is the center and controlling influence of the entire system.

(2) The major planets—Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune.

(3) The minor planets, of which about eight hundred are known to astronomical science.

(4) A class of secondary planets called moons or satellites which accompany most of the major primary planets on their annual journeys around the sun, and which, in the points of position and movement, bear the same relation to their respective centers of revolution that the primaries themselves bear to their own common center of revolution—the sun. The earth is one of the major planets, and the moon is its only satellite or secondary.

(5) The comets belonging to the first class, or those that move in elliptical paths and revisit the sun periodically.

(6) Meteors and shooting stars.

(7) The zodiacal light.

CHAPTER II

A CONTRAST OF FORMER AND PRESENT ATTITUDES TOWARDS SCIENTIFIC ACHIEVEMENTS

Astronomers in all ages have sought to calculate the distances of these remote orbs from the sun and from one another, their dimensions, their periods of rotation and revolution, etc.; and in spite of the facts that during the respective ages in which they lived the science of astronomy was comparatively in its infancy and the equipments for performing such tasks were very simple, those pioneers of science were able to make estimates approximately correct. But the full and perfect confidence of the common people, in the ability, the accuracy, and the truthfulness of the forerunners in scientific speculations has not always existed. And even many of the contemporaries of those progressive leaders, who were learned men and women engaged at high pursuits, and who were almost or quite the intellectual peers of those earlier astronomers, discredited the truths set forth by them in their publications, doubted their sincerity, and even censured them for indulging in what the world at large then termed folly.

In some of the more enlightened countries of Europe

this general lack of confidence gave rise to severe legislation against the publishing of any opinion, theory or truth relative to the distances, the dimensions, or the motions of the heavenly bodies, unless the content of such publication was strongly supported by the solid foundation of evidence. For offending against said law some of the world's greatest thinkers, even in the time of Galileo and Copernicus, were arraigned before the courts of justice, tried, and condemned. After the sentence to punishment had been uttered, the offender in such cases was sometimes given the option of regaining his liberty by swearing on bended knees that his publication was willfully and knowingly false, or of paying the penalty of violated law, which was either long confinement in a dungeon, or death.

At the present time no such law as the one referred to in the foregoing paragraph exists in any of the civilized countries on the face of the globe to hamper thought and to retard scientific progress. The absence of such restrictions from the statute books of all countries is the strongest and best evidence that the people of every race and nationality are more open to conviction than they were in former times and therefore becoming more thoroughly educated, wiser, and better. I am truly glad that I live in such an age,—an era when the subjects of all countries may freely use and enjoy such a privilege as the freedom of speech and of the press, at least in all matters pertaining to scientific subjects and speculations, without placing their lives in jeopardy.

Before any craft heavier than air was ever propelled and guided through the aerial regions above us, the Wrights declared that it was a matter of only a short time when airships would be more numerous than the

ships upon the sea ; and at the time when wireless telegraphy was talked of by a few merely as a possibility and thought of by the masses of the people as nothing short of wild speculation, Marconi asserted that within the short period of five years we would be receiving messages from ten thousand miles away without any apparent medium of communication. Before these blossoms developed and ripened into fruits all the enlightened countries of both hemispheres were dicker for the products. The world did not wait to see the undisguised expositions of these three great modern geniuses come true, but at once had faith in their magic utterances and touch and received their explicit assertions without question or criticism. These are only two of many examples that might be given to illustrate or to prove the unbounded faith and confidence that the people everywhere now have in the pioneers of science and art.

Most competent authorities are now urging upon us the prediction that fifty years hence our means of locomotion will be such that we can with perfect comfort and a reasonable degree of safety cross the continent from New York City to San Francisco within the limits of eight or ten hours. Perhaps no one doubts for one moment the possibility nor even the probability of such facilities in the way of travel within this comparatively short time. During the last half century such immense strides have been made in the sciences and the arts that now scarcely anything seems unreasonable to the higher grades of intelligence.

And now if the most progressive men and women of the age, and the ablest scholars and the profoundest thinkers found today among scientists and inventive geniuses of the highest order were to dare assert that

it is not only possible but very highly probable that within a comparatively short time a means will be invented by which we can make safe and rapid transits from one heavenly body to another, would you not look forward to such an accomplishment with expectant attention and a high degree of unwavering faith? Why certainly you would. To do otherwise would be to get entirely out of harmony with the general upward trend of thought which characterizes the people of this, the most progressive age in the world's history.

Now without the slightest fear of placing his life in jeopardy, and in the confident hope and the belief that the truth of his story will readily be accepted by every grade of intelligence and with the same high degree of confidence with which they now receive the theories, the predictions, and the assertions of the progressive leaders along every line of thought, the writer takes pleasure in publishing to the world for the first time the startling fact that an ethereal ship has already been invented and constructed, which has the wonderful power of neutralizing the force of gravitation and of propelling itself at a high rate of speed through the free space of the heavens. And he takes pleasure in stating further that it has been his pleasure and fortune to have been a member of the first and only party to make in this craft a transit from the earth to the moon and a safe and speedy return.

CHAPTER III

HOW THE WRITER BECAME A MEMBER OF THE PARTY TO GO ON THE LUNAR EXPEDITION

It was by mere accident that I became a member of the party to go on this perilous voyage. It came about thus:

I was on my way to Urbana, Ill., and was waiting in the union depot at Terre Haute, Ind., for my train. I was sitting almost alone in the south wing of the waiting room, when a well-dressed, versatile, but unassuming man apparently about forty years of age approached me and introduced himself as Ewald.

"When is the fast train bound for St. Louis, Mo., due to leave Terre Haute?" inquired he.

"I do not know," I replied. "I am a stranger here, and not familiar with the time table."

He then voluntarily informed me that he was directly from Westchester, Pa., had failed to make the proper railroad connections, and was due in St. Louis on urgent and important business. He then walked hurriedly away in the direction of the bureau of information.

After the lapse of about five minutes this busy man returned, took a seat, and handed me a large, clean sheet of high-grade, heavy paper bearing a photo-en-

graving of a strange-looking craft of which he claimed to be the inventor. As I extended my arm to take it from his hand he said:

"This is an exact representation of an ethereal ship which is soon to make a safe and rapid transit from the earth to the moon and to carry fifteen passengers."

For some time this enthusiastic man talked steadily and fluently about his ship of which he was to be captain on the proposed voyage, while I gave him respectful attention. Pretty soon I arrived at the conclusion that he was of unsound mind; and for this reason I asked no further questions, and for the time being the conversation directly between him and me ceased.

Captain Ewald, as some of his newly-made acquaintances had already begun to call him, in derision perhaps, next engaged the attention of two or three well-dressed by-standers by exploiting his great invention and by his strong and spirited argument in favor of its merits.

After the lapse of some thirty minutes I again engaged him in a conversation.

"Captain, by what means do you expect to overcome the attraction of the earth and to continue your voyage," I asked, "when your ship ascends to the limit of the earth's atmosphere where there is absolutely nothing to offer it resistance?"

"The merits of my ship," replied he without a moment's hesitation, "lie principally in two things, namely, its power to neutralize or to destroy the force of gravitation so that neither the attraction of the earth nor that of any other heavenly body can possibly exert any influence upon it, and the power to propel itself through the free space of the heavens at the

terrific speed of three hundred and sixty miles an hour, or almost six times as fast as the swiftest express train."

I treated his assertion as a joke. That any contrivance could possess such merits as he claimed for the running gear of his ship appeared to me at that time to be utterly absurd, or as incredible as the possibility of perpetual motion; yet, the high degree of intelligence the inventor seemed to possess, his unbounded self-confidence, and his earnest demeanor, all considered together, gave me at least a little faith in him and his enterprise.

Just as the captain uttered the last word of his statement in reference to the merits of his ship, the express train destined for St. Louis arrived. By that time I was beginning to take a truly lively interest in my newly-made acquaintance and his project.

As we walked on together in the direction of the train, he introduced me to Messrs. Vanderlip and Waite, two of his young friends who were traveling with him, and told me briefly and hastily that the ship was complete in every particular, and that the departure for the moon would be taken the following week from some point near St. Louis. He stated further that the ship had been constructed strictly according to his own specifications and directly under his own observation, by skilled workmen under secrecy, and charged me particularly to make no mention of the proposed voyage in connection with his name.

He then informed me that the two young men who were with him had linked their destiny with that of his ship and would make the voyage with him, and told me that if I wished to do likewise he would, as early as possible, consider my general fitness for such

a venture. I then asked the privilege to become a member of the party to go on the Lunar Expedition, and in due time it was granted. This meeting occurred on Friday, November 13, 1914.

On the following Thursday in a suburb of Alton, Ill., Capt. Ewald, according to a previous arrangement, organized the company to go on this expedition and demonstrated to the entire satisfaction of its members that his means of conveyance possessed all the merits he claimed for it.

The individual members of this company, who dared unite their destiny with that of the ship were as follows:

Captain Horace Bryson Ewald of Brockton, Mass., inventor of the mysterious running gear of the ship which carried us; Prof. Burwell Esten Rider of La Crosse, Wis., who assisted the inventor in steering the craft; Prof. Charles Ulric Thorsen of Gothenburg, Sweden, and Prof. Purdy Warford Knowlton of Birmingham, Ala., aviators while touring the moon; Prof. Daniel Crowley Monahan and Thomas Nolan Galvan, mathematicians and scientists of more than ordinary ability, late from the University of Dublin, Ireland, who made the voyage with the view to adding something to science; Dr. Marion Dade Wharton of Atlanta, Ga., our physician, who formerly held the chair of Materia Medica and Therapeutics in the Medical Department of Tulane University, New Orleans, La.; Prof. Hanson Goodwin Brunor of St. Louis, Mo., foreman in the heavy construction work of the sitting room and the dome of the ship; Prof. George Hundley Purnell of Philadelphia, Pa., machinist and electrician, who installed the air compressors, the storage batteries, and the running gear of the ship; Messrs. Walter Hummel

Vanderlip and Frank Gilman Waite of Brooklyn, N. Y., photographers, and old acquaintances and friends of Capt. Ewald; the Rev. Bryan Collis Merritt of Lincoln, Nebr., a student of theology and a nephew of Dr. Wharton; Mr. Warren Newell Shipley of Brownville, Tex., Capt. Ewald's private secretary; Dick Prouty, a typical North Carolina colored man of Bellville, Ill., who was cook during the voyage and chauffeur while touring the moon; and the writer, who went along merely to be an assistant in all light and simple matters and to see the sights.

CHAPTER IV

THE EQUIPMENT FOR THE VOYAGE

The equipment for the voyage consisted, for the most part, of the following:

1. The ship that bore us away to a foreign world and in due time transported us back to earth again and landed us safe at home. This craft together with its propelling machinery and other necessary installments was not only a strange-looking and complicated piece of mechanism, but a thing of magnitude, strength, and beauty, as well.

(a) This most mysterious of all conveyances, which by its power to neutralize the force of gravitation and to propel itself rapidly through space without a resisting medium has placed us in close touch and direct communication with other worlds than ours, was primarily divided into a sitting room and an air dome. In shape the sitting room was that of a right octagonal prism and contained in round numbers, one hundred and fifty-five thousand cubic feet of breathing space. The dome resembled an egg slightly flattened on the sides and placed on end with the point directly upward and had a volume of eight hundred and sixty thousand cubic feet. In other words, this ship had a floor whose



FIG. 4. PROJECTIONS OF A FEW COMETARY ORBITS
ON THE PLANE OF THE ECLIPTIC.

(Steele's Astronomy.)



FIG. 5. A METEOR TRAIL.

(Yerkes Observatory.)



FIG. 6. STAR CLOUD NEAR MESSIER 8.

Under most favorable atmospheric conditions less than a dozen stars on this plate can be seen from the earth's surface with the naked eye.

(Yerkes Observatory.)

perimeter was two hundred and thirty feet, and a dome with a circumference of three hundred and forty-six feet; and, when placed in an upright position or sitting posture, it stood two hundred and thirty-four feet in the air.

(b) The sitting room contained six observation windows each of which consisted of a perfectly transparent pane of glass two by three feet and ten inches thick, which were strengthened by a wide border of thick steel plate and closely fitted into the openings by means of broad, deep, metal-lined grooves. It was estimated that these panes were capable of safely resisting fifteen thousand pounds of atmospheric pressure at the level of the sea. A rostrum twelve feet wide and fourteen inches high bordered by a balustrade of heavy nickel-plated wire with four-inch meshes extended entirely around the room.

(c) The dome was divided by partitions into six apartments for carrying compressed air, all of which communicated directly with the sitting room but not with one another. The separating of the dome into several chambers was a precaution against losing all of the pent-up air, during our transits, in the event of a puncture by flying meteoric stones.

(d) A steel pipe or barrel ten inches in diameter and with an eight-inch bore extended from one of the chambers in the dome directly downward through the sitting room. All objects to be cast out were discharged through this pipe. A circular door supported by a strong hinge opened into the pipe from the sitting room. Through this opening into the pipe the object to be thrown overboard was passed, after which the door was closed and fastened by means of a strong, close-fitting, steel band, and then compressed air was

turned on from the dome. In this way any object not too large could easily and quickly be expelled either gently or with great force.

(e) The floor, the walls, and the partitions of both the sitting room and the dome were very thick and strong and consisted, for the most part, of alternate layers of thick, heavy paper, large sheets of hard wood and of steel plate five-eighths inches thick thoroughly coated over with pitch and drawn closely together by means of strong steel bolts and nuts.

(f) The whole of the exterior of the ship was coated with thick, highly-polished plates of aluminum, which at a distance gave it a pale-blue, translucent appearance; and when fully exposed to the bright light of the sun, this stupendous craft glistened like an iceberg.

(g) The curved surface of the dome and the hard material of which the walls and the partitions were constructed, together with the manner in which they were built and braced, made them absolutely air-tight and capable of resisting almost any degree of atmospheric pressure from within and gave at least a partial guarantee against punctures by flying missiles from without. The entire cost of both the material and the construction was approximately two and a half millions of dollars.

(h) Seven huge compressors were installed—one in each apartment—and thus became practically a part of the ship. These condensers were mainly for the purpose of compressing air into the chambers of the ship in the event it was found that the atmosphere surrounding the moon was too highly rarefied, in its natural state, for breathing purposes.

(i) Three large Edison storage batteries of the submarine-boat type also were installed, and like the com-

pressors, became practically an essential part of the craft. These batteries furnished heat for the physical comfort of the passengers and the crew and for lighting and cooking purposes, and kept the pent-up air in a wholesome state for breathing. The potash solution with which this particular type of battery is charged absorbs carbon-dioxide, while an appliance for generating oxygen completes the system of air-purification and rejuvenation. There was sufficient potash in the three batteries installed to absorb all the carbon-dioxide expelled by the persons on board the ship in a period of twelve months. Mr. Edison had practically completed this type of battery by the close of the year 1912, and it was this that made voyages to other worlds possible and led Capt. Ewald to lend his intellectual energy to inventing the mysterious running gear of his ship. Before the installation of these batteries they were subjected to the most drastic tests to prove their fitness for the important service which they were to render.

2. Fifteen couches—one for each member of our party—and an abundance of heavy, comfortable bedding.

3. Fifteen suits of clothing made of high-grade, heavy material, and much after the pattern and kind usually worn by arctic explorers.

4. Approximately one million cubic feet of air indicating a barometric pressure of sixty pounds to the square inch, and a sufficient quantity of plain but wholesome and nourishing food for the entire party for a period of twelve months, including six thousand gallons of water, a coop of five dozen chickens, six pigeons, and a gander.

5. Five dozen closed, copper helmets which, while we were touring the moon, rendered a service without

price. A more minute description of this helmet and how it was equipped will be given in a subsequent chapter.

6. One thousand feet of half-inch hemp rope, two and a half dozen pairs of heavy gloves, and forty-five pairs of climbing shoes.

7. Fifteen heavy reclining chairs with cushion bottoms, fifteen small legless tables which folded beneath the arms of the chairs, and two cooking stoves.

8. A Ford car, a Wright biplane of mammoth proportions, and a goodly supply of gasoline and storage batteries. These machines were taken along in the confident hope and belief that the surface conditions on the moon would be reasonably favorable to our making in them interesting and profitable, short, side-trips from our stops along, while touring our neighboring little world. These means of conveyance were selected from among other makes on account of the genuine service which they render in the way of speed and endurance due largely to the high-grade material of which they are built and the excellency of workmanship put into them.

9. One twelve-inch, clear-aperture, telescope and some spectroscopic attachments obtained from the Yerkes Observatory at Williams Bay, Wis., and one dozen small high-power telescopes.

10. A theodolite with armillary-sphere attachments, a cabinet of drawing and plotting instruments, and a ream of paper.

11. A dozen thermometers and as many barometers, a supply of chemical apparatus including blow-pipes, spirit-lamps, retorts, etc., and a supply of chemicals.

12. A typewriter, one and a half dozen ear trumpets, seven clocks and nine watches, and a photographer's complete outfit.

13. One spade with a long narrow steel blade, one common chopping ax, three rock picks, two sledge hammers, one drill, and a supply of fuse, powder, and dynamite.

14. A supply of tacks, screws, and small bolts and nuts; a hundred-pound coil of No. 14 wire; two or three armloads of light, hard, finishing lumber; three bolts of strong, high-grade ducking, and a half dozen buckets of black paint and three paint brushes.

15. One small chest of handy and useful little tools, such as gimlets, hammers, scissors, screw drivers, wire pliers, etc.

CHAPTER V

THE EQUIPMENT FOR THE VOYAGE—(Continued)

Recently, while relating to a lady friend some parts of this story, I had occasion to enumerate in a kind of general way the articles that made up the bulk of our equipment.

"In the name of truth," exclaimed she, with a look of intense surprise, "how did you manage to pack so much junk into so small a space?"

"Now, Miss M——, if it appears to you to be inconsistent with reason that so much could be packed into so small a space," I replied, "please get and keep in mind three things: first, that the ship was not by any means a mere toy; secondly, that the way in which a great many of the bulky articles of equipment were turned to ready use prevented our having to pack them away in receptacles; and thirdly, that the manner in which nearly all the food supplies were prepared for packing called for less room than otherwise would have been required."

"I want you to tell me," demanded the young lady impatiently, "where you placed all these things. I can not understand how you had room to move about."

"Just beneath the floor of the sitting room, which was twelve feet above the ground, and extending en-

tirely around the craft," responded I, "was a line of cargo chests prepared especially for packing away stores of every kind necessary."

"Where did you place the huge compressors, the cooking stoves, and the beds?" she inquired. "I should not think," she added, "that you stored them away with the rest of the things in the receptacles."

"The air compressors, the large storage batteries, and the cooking stoves were installed in out-of-the-way places," answered I, "and were ready for immediate use when the need demanded it. The couches on which we slept were securely fastened to the walls, and when not in use, folded back with the bedding out of the way and out of sight like the upper bunks in a Pullman palace car."

"And the mammoth Wright biplane which you say was sixty-five feet from tip to tip of the wings—how did you pass it in at the door," she asked, "and where did you find room for it after you got it on the inside?"

"The biplane and the car were separated completely into their component parts," I explained, "and together with the food supplies, gasoline, etc., stored away in compact bulks in the chests. In short, not an article of equipment was visible in the sitting room, except the fifteen large chairs, the table on which sat the typewriter, and the large telescope and its mountings."

"It appears to me," said she, "that your food supplies would have taken up an immense amount of space."

"Profs. Monahan and Galvan, two eminent scientists and very prominent members of our party," replied I, "thought that possibly we might be surrounded, at least much of the time during the voyage, by physical conditions favorable to the decomposition of our food

supplies. For this reason, they advised and directed that our commissary stores, and especially the milk, the eggs, the meat, the fruits, and the vegetables, be conserved by some process of drying and powdering; and their orders were carried out, which greatly reduced the bulk and the weight of this class of supplies."

"By what means," then inquired she, "did you preserve your store of provisions?"

"The machine used for this purpose," I said in reply, "is a comparatively recent invention of Mr. G. A. Krause, an engineer of Munich, Germany. By the application of a centrifugal force, rather than by that of heat, this combination of mechanical powers quickly and absolutely extracts the last vestige of moisture in a few seconds, from any and all kinds of foodstuffs, without removing any of the valuable ingredients. A gallon of milk placed in the machine and rapidly revolved, was quickly transformed, right before our eyes, to a whitish, vapor-like powder. This was the first test of the machine's work that came directly under my observation. Unlike milk which has been reduced to powder by the application of heat, the fluid treated in this centrifugal-motion machine loses none of its nutritive value, and when this powder is mixed with the proper proportion of water, an hour or even a year later, it becomes real, pure milk again, and tastes exactly like the original. It contains, as chemical analysis shows, every one of the characteristics and properties of milk, and produces a thick rich cream—providing the original did—from which butter may be churned."

"Well, what kind of a looking piece of mechanism is this wonderful machine," inquired she, "and how is it operated?"

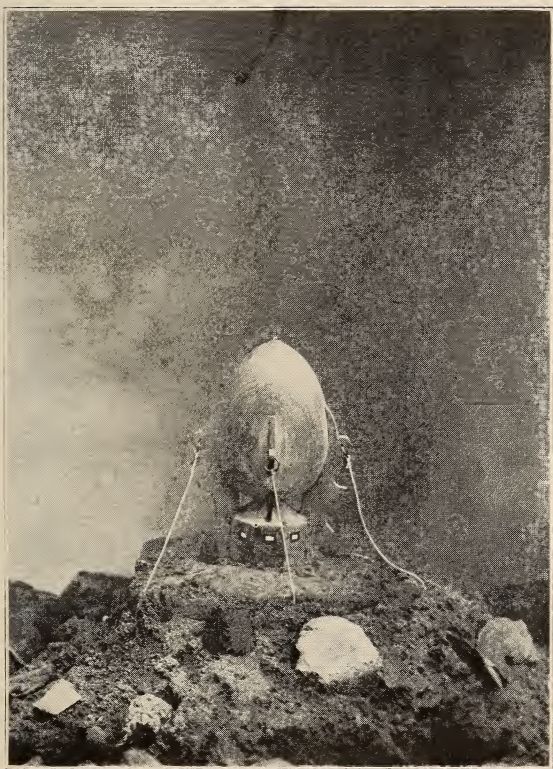


FIG. 7. CAPT. EWALD'S MYSTERIOUS CRAFT.

The ship that bore us away to a foreign world and in due time transported us back to earth again and landed us safe at home.

"This machine is cylindrical in shape, and about six feet in diameter and twelve feet long," I responded, "and resembles a huge wooden boiler stood on end. It is operated by electricity, and since no movement is visible, when the motor is turned on, and the drying process is astonishingly rapid, the mysterious transformation of any and all kinds of edibles before one's eyes is almost uncanny."

"Explain, if you please," she insisted, "the process by which the transformation of food takes place in the machine."

"Two days of the week before our departure for the moon," said I in response, "Mr. Oliver B. McGuire, a representative of Mr. Krause, operated this machine at Alton, Ill., in preparing our stores for packing. During these two days this representative revealed to the scientific men of our party and to a representative of a large canning factory of Kansas City, Kans., the exact process by which the transformation takes place, and the machine was open to inspection by anybody and everybody, but I failed to take sufficient interest in it to understand the workings of it. Perhaps my lack of interest," I concluded humorously, "was due largely to the fact that my mind was at that particular time engaged with bigger thoughts—so elated over the anticipated grand explorations of the heavens and of other worlds than ours, that the study of a food-drying machine appeared rather tame."

"I would not have taken any chances like that," she said emphatically, "for I would have been afraid we could not have changed that powdered-up stuff back to wholesome food again."

"On the day Mr. McGuire finished the work of preparing our food for packing," I explained, "he extended to

all of us and to a few others an invitation to dine with him. He poured a quantity of milk into the machine and within a few minutes dried it and ground it to powder. He then repeated the process in succession with eggs, fruit, potatoes, meats, etc., and all in turn were completely and quickly dried and reduced to dust. The various powders were then gathered up and taken to a kitchen there in Alton to test the efficiency of the work done by Mr. Krause's machine. With the guests still watching, amazed and almost incredulous, Mr. McGuire added water to the powdered milk in the right proportion. The powdered eggs he put into a large frying pan, added water and butter, and in a very short time had a tasty and attractive dish of scrambled eggs. The fruits he transformed into a sort of marmalade, and the potatoes, meats, etc., he served still in other ways. Then we all sat down to lunch. After the meal had been served, Capt. Ewald stated to a newspaper correspondent, in behalf of all who partook of this meal, that each and every dish prepared from the dried and powdered products tasted absolutely like the original foods and that no flavor had been lost. So you see we took no risk at least along this line."

"What then did you do with all these dried and powdered products?" she inquired.

"All our food supplies thus prepared—a quantity sufficient to last our exploring party for a period of twelve months—were then closely packed in strong, neat, paper boxes prepared especially for that purpose," I said in reply, "and stored away in a dry place for safe keeping until we were ready to take our departure."

"Did you really go on a trip to the moon, or are you merely joking?" inquired she earnestly.

"You had as well doubt the voyages of Sinbad the Sailor, the travels of Baron Munchausen, the adventures of Gulliver, or the simple life of Robinson Crusoe," I replied.

"Now I want you to leave off idle talk," she urged, "and tell me the truth."

"Please curb your curiosity on this point until I have finished the story," said I, "and then I think that instead of doubting, you will only wish you had been one of the party who went on this wonderful expedition."

CHAPTER VI

OUR DEPARTURE FOR THE MOON

Very early on the morning of November 22, 1914, the day of our departure, all the members of our party, at the command of Capt. Ewald, convened at the residence of Mark P. Hoover, a prosperous farmer living in the vicinity of the place where our ship was moored, to hold the last consultation in regard to the equipment for the long and perilous voyage.

After we had been gathered about three hours an intelligent-looking, comfortably-dressed young man in working attire presented himself at the door of the room which we were occupying and informed Capt. Ewald that all the supplies had been packed and loaded on according to directions. The meeting at once adjourned, and as we all walked on in the direction of the ship, Capt. Ewald instructed us to keep our real intention strictly a secret and to convey to all persons not in any way directly concerned the idea that we only expected to take a record-breaking air flight.

When we reached the ship, we found it closely guarded and protected by a strong force on the inside of barrier ropes and surrounded on the outside by a great throng of noisy men and boys. This rough crowd had gathered, no doubt, to witness a great calamity; but they were evidently very much disappointed, for

everything worked out that morning in our favor in the minutest detail, and the beginning of the flight was, in every way, a most prosperous one.

The point from which we made the ascent was a small, rocky eminence in a little meadow on the farm of Perry G. Lowman, situated on the right bank of the Missouri river, and about eight miles above its mouth.

Exactly at 10 o'clock A. M., central time, we were commanded to go on board, which orders we promptly obeyed. Then the moorings were cut and the massive door closed, locked, and sealed.

The promoters of this enterprise took their positions at the running gear, and the rest of the party, for reasons which they could never thereafter satisfactorily give, quickly gathered themselves into a compact squad at the center of the sitting room and stood with bated breath waiting for the results of the first attempt to rise into the air. Then Capt. Ewald, acting in the triple capacity of engineer, pilot, and captain, pulled a lever and briskly turned the steering wheel. At once the great bleb-shaped craft began to quake all over as if it had a violent convulsion, gave a long, loud, doleful moan, and leaped wildly from its ponderous foundation and started upward. At first it moved slowly with a few slight jerks, and then with the swiftness of a skyrocket rose steadily to a great altitude and floated gently away through the aerial regions in the direction of Hillsboro, Ill.

As our ship sped upward, I heard faint shouts from the excited crowd below, and the individual members of this boisterous assemblage rapidly took on Lilliputian dimensions and finally disappeared in the distance. Countless villages and small towns scattered about over Eastern Missouri and Western Illinois almost suddenly

popped into view, and the woodlands everywhere took on the appearance of great briar fields.

The morning was almost perfectly clear, and the day being the Sabbath, there was practically no smoke in the towns and the cities, conditions highly favorable for getting fine landscape views. From our elevated position the City of St. Louis more than twenty miles away was in plain view and rapidly shrank away to a mere toy city as our ship steadily drifted away to the East. In about one hour after our ascent this great inland trade-center had narrowed down until the skyscrapers resembled box-cars standing on end, and together with the adjacent towns and villages, disappeared in a southwesterly direction.

At 11 o'clock—just one hour after we begun our flight—the thermometer recorded the temperature on the outside at 6 degrees Centigrade, above 0, and the barograph registered our altitude at twenty-two thousand seven hundred and sixty feet, or about four and one-third miles. The exact latitude and longitude of our ship just at this particular time I did not know; but, to the best of my knowledge, we were about ninety miles almost due west of Evansville, Ind.

The sky had by this time become somewhat murky, and for this reason I was not able to get very sharp outlines of small objects on the earth's surface; but all large objects, such as farmhouses, stock barns, etc., even within a radius of forty miles, loomed up well in all their coarser details. I was able also to trace with my unaided eyes for quite a long way the courses of a number of small streams and two railroad lines, and to locate readily at least two dozen small towns and villages scattered here and there over the country. From my viewpoint these more directly underneath the ship

appeared as clusters of large boxes, more than anything else, while those more remote resembled scattered flocks of geese.

While some seven or eight of us were temporarily engaged at discerning, naming, and locating objects on the earth's surface and exchanging ideas in undertones and whispers as to what we thought would be the outcome or end of our reckless venture, Capt. Ewald who had for some time been aside in consultation with Prof. Rider stepped quickly forward, commanded attention, and said: "Gentlemen, we are now ready to leave the world, and you may at once prepare for the longest, and fastest, continuous ride that you can ever reasonably hope to take in this life."

We all promptly took standing positions and clung to some nickel-plated rods that extended from the center of the floor to the ceiling. Capt. Ewald and Prof. Rider immediately took positions at the helm, and with the expressions of the intermingled feelings of dread, hope, and defiance, began a rapid, skillful, and harmonious manipulation of a complicated system of wheels and levers. In another moment the giant craft hummed aloud and for several minutes rocked slowly round and round in the manner of a spinning top, and I felt a sensation as of a great weight pulling down upon my shoulders. Presently the sky began to turn black, a gloaming darkness gathered about us, and objects on the earth's surface began to grow indistinct. Just at this moment I heard a locomotive whistling and a large bell tolling, away in the distance, but I could not locate them. These were the last sounds I heard on earth until we returned from the moon.

In about thirty minutes, after having traveled directly upward a distance of about one hundred and

seventy-five miles, we discovered that there was no atmosphere about us; or, if there was, it was so highly rarefied that it was not discernible by means of the most delicate and accurate instruments prepared especially for determining such conditions.

Here we "cast anchor" for thirty minutes. While our ship floated lazily and quietly about in the free space of the heavens, Capt. Ewald and Profs. Monahan, Purnell, and Rider were aside from the rest of the party holding a spirited consultation and studying the directions. At the end of this short period the sun was directly over our meridian, and the moon was plainly visible at a point in the heavens 65 degrees east of the sun, and was just five days on the journey from new moon to first quarter.



FIG. 8. OUR DEPARTURE FOR THE MOON.

At first it moved slowly with a few slight jerks, and then with the swiftness of a sky-rocket rose steadily to a great altitude and floated gently away through the aerial regions, in the direction of Hillsboro, Ill.



FIG. 9. A PANORAMIC VIEW OF THE HEAVENS.

This picture gives the reader a faint idea of the view that presented itself to us when we were at a distance of two hundred miles from the earth's surface and aids him in realizing what the mind can not grasp—the immensity of the universe and the immeasurable distances in trackless space.

If we had a means by which we could travel uniformly a mile a minute, day and night, and were to speed our course in the direction of the remotest planet known to astronomical science, it would require five thousand and fifty-five years to reach the end of the route. Traveling at this same speed it would require forty million years to reach the nearest fixed star.

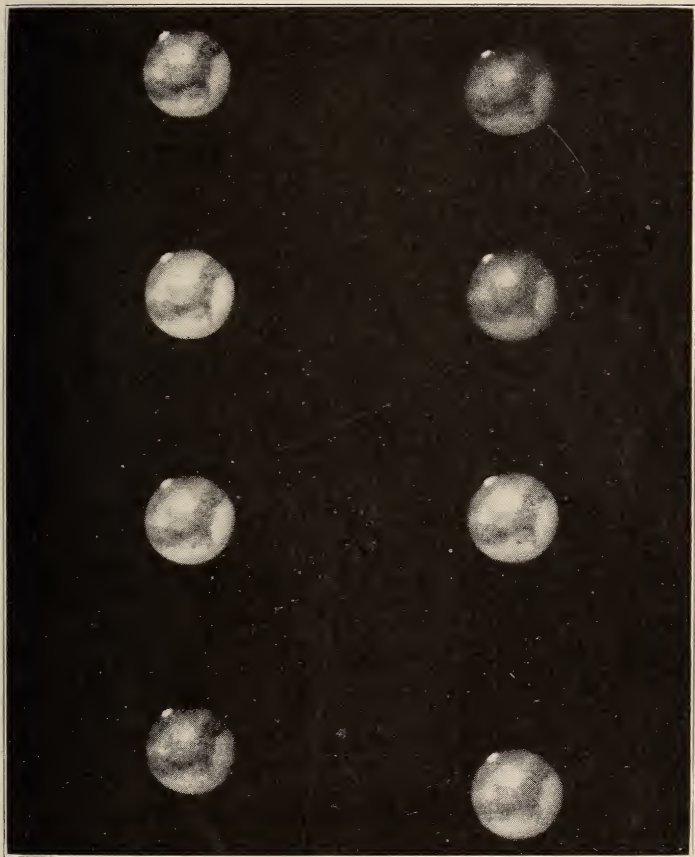


FIG. 10. THE PLANET MARS, 1909.

(Yerkes Observatory.)

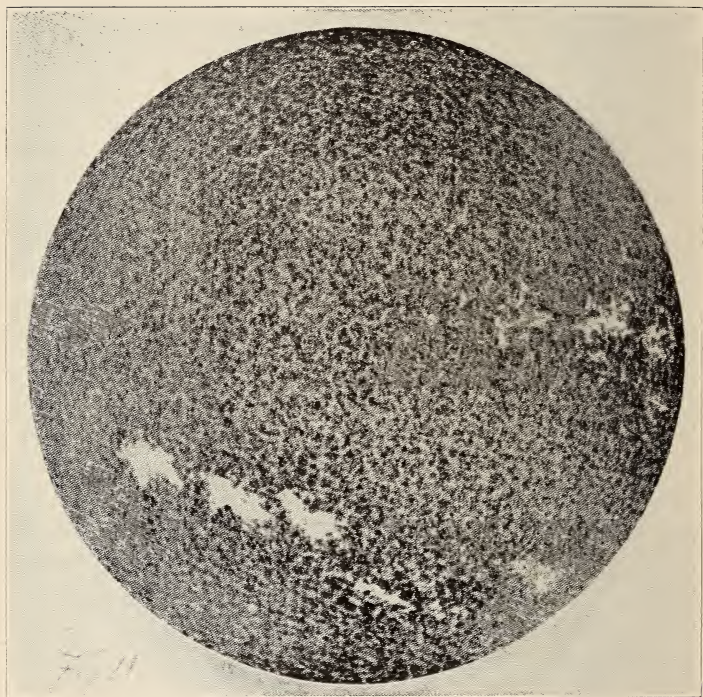


FIG. 11. THE SUN, PHOTOGRAPHED WITH THE
SPECTROHELIOGRAPH, 1913.

The white blotches are areas of intensely brilliant calcium vapor, which would be invisible on an ordinary photograph.

(Yerkes Observatory.)

CHAPTER VII

THE FIRST DAY OF THE VOYAGE

Just at this moment, 12 o'clock noon, on the day of our departure, Capt. Ewald resisted the ship's eastward motion due to the earth's rotation until it was completely overcome, and then the sun ceased his westward flight across the sky and the earth went spinning upon her axis. He then chose the direction of a star with which the moon was at that moment almost in direct line, gauged the ship to this course, and turned on the power. On our craft went day after day through the boundless and dread immensity of space at a speed that must have been equivalent to that of a cannon ball. He held steadily to and bore down upon this course for a period of a little more than twenty-nine days, and in the meantime covered a distance of almost two hundred and forty thousand miles.

After the final start, or our departure proper, even though we were in every way well and thoroughly equipped, I truly regretted that I had ventured to take this trans-ethereal flight, because I thought then that I realized it was not possible for us to get by the dangers that would beset us on every hand. The ship had the tremors and was running in a somewhat jerky manner. Capt. Ewald and Prof. Purnell were at the running gear trying to adjust properly some of the

machinery that did not seem to be working fitly. Prof. Rider, who was the only man in the company other than the captain, who could steer the ship, was standing quietly near the center of the sitting room and looking anxiously toward the helm. The rest of the company were seated in the chairs looking wonderingly about at one another. I do not know what others thought nor how they felt; but, as for myself, I entertained the fear that Capt. Ewald and Prof. Rider did not feel themselves masters of the situation. I tried to discern in their actions and in the expressions of their faces a sufficient amount of self-confidence to allay within me the painful emotion of fear excited by the apprehension of impending danger.

Presently the ship righted itself and sped smoothly onward. Everybody appeared greatly relieved, and there opened up at once an all-round conversation. Capt. Ewald left the helm, walked straightway to Prof. Rider, and with a broad and pleasing smile on his face spoke as follows:

"We are now gone; there will be no stopping along the way to let off and to take on passengers; the next landing will be the moon."

Prof. Rider returned the smile, and in reply said:

"And high she shoots through glorious light,
Above all low delay,

Where nothing earthly bounds her flight,
Nor shadows dim her way."

Immediately after the ship had been set free from the earth's rotary motion and the excitement had partially subsided, I prostrated myself upon the floor to peer through one of a number of rectangular panes of glass which had been placed in the floor and arranged so as to form a decagon around a central, upright shaft,

to get a view of the earth. I shall never forget the impression this scene made upon me. I saw the earth's surface plainly—even more so than when we were within her atmosphere; and by the aid of one of the small telescopes I saw distinctly all the beautiful silvery streams of the great Mississippi system threading their courses through the country and readily discerned the relief in the elevations of every character, and by them easily followed with my eyes the trend of the ranges of hills. I had also a fine survey of most of the Great Lakes and an excellent view of all the large cities within a radius of five hundred miles, including St. Paul, Minn.; Lincoln, Nebr.; Little Rock, Ark.; Birmingham, Ala.; Atlanta, Ga.; Columbia, S. C., and Pittsburg, Pa.

But it was not the mere fact that I could see the familiar objects enumerated above, at distances so immense, that interested me most; rather, it was the sublimity of the scene that startled me. Although we were moving onward at the almost incredible speed of three hundred and sixty miles an hour, our ship seemed to be standing perfectly still in free space and the earth appeared to be falling from under us as if destined for some great and powerful center of attraction, or even for the uttermost bounds of space; but this was an optical illusion—it was the craft that was moving. I could plainly see the earth, a great, hazy, murky mass, going on her rapid heavy swing upon her axis. The first impression made upon me was that the law of universal gravitation had failed and that as a result the universe was wrecking or going into disorder.

For perhaps fifteen minutes after the final start the ship had been running steadily, when we all slowly and cautiously distributed ourselves around the walls of the

sitting room and for the first time gazed with unobstructed view and profound interest through the panes into the infinite realm of God's dominion. Not a smile played over any one's lips, scarcely a word was spoken for more than an hour, and I saw clearly depicted in every countenance an expression of the intermingled feelings of fear, awe, and reverence.

The last vestige of my fears occasioned by the perils of the situation departed as I stood gazing into the trackless and shoreless ocean of space at the sublime and awful beauty that from every direction in which I turned my eyes met my anxious gaze. This general view of the heavens was the most appalling and sublime spectacle that I ever beheld or ever expect to behold this side the Judgment Day. No human language as a vehicle for thought is competent even to begin to approach a description of a thing on a scale so stupendous, and the sensation produced by such a panoramic view of the heavens can only be thought of and felt in the soul. (See Fig. 9.)

The great concave of the celestial sphere was as black as night. The planets and their satellites, more than five hundred in number, were at once in plain view and appeared much nearer than when viewed from the earth through an atmosphere laden with moisture, dust, and gases, and all of them, even to Deimos and Phobos, the two little satellites of Mars, familiarly known as Dread and Terror, presented well-defined disks and shone with a clear, steady light as they moved on their unknown celestial rhythm of the universe. More than a hundred comets not visible from the earth through a powerful telescope were pretty evenly distributed over the concave of the sky in the vicinity of the sun and moving in every conceivable direction. The

fixed stars, which had come out by hundreds of thousands never before beheld by mortal eyes, appeared to be at almost infinite distances and shone with a steady, white luster. (See Figs. 6 and 29.)

And the sun, by far the most conspicuous of all objects within our ken of vision, whose great corona had apparently arranged itself into a system of concentric rings or bands, was sending off the most luminous cones of rays and pearly streamers of light, with great intensity, for millions of miles, into the dark expanse of the heavens.

At this time Mars, which is almost the size of our own world and which is nearest to the earth of all the superior planets belonging to the major class presented a wonderful aspect. It stood out in bold relief and was, indeed, a "beautiful world on high." With my unaided eyes I easily traced the shores of its seas and oceans, the bounding lines of the deserts and the verdant regions, and saw very distinctly the south polar "cap" due probably to ice and snow in the planet's polar regions. By the aid of the great telescope Profs. Monahan and Galvan made a photograph of it. (See Fig. 10.)

After a partial relaxation of our nervous tension due to the magnificence of the panoramic view of the heavens before us, Prof. Galvan called us to the large telescope to take a view of the sun. This is a wonderful sight. The telescope reveals that the surface of this great luminary has a peculiar mottled appearance not unlike that of an orange skin, and that it is covered also with small, intensely bright bodies irregularly distributed. The light from different parts of the solar disk, one observes, varies in color—that arising from the edges being of a chocolate hue, while that emanating from the center has a decidedly blue tint.

The sun's distance from us is ninety-three millions of miles, a magnitude so great that if a railroad could be built from the earth to this great luminary, an express train, traveling day and night without stopping, at the rate of thirty miles an hour, would require three hundred and fifty-two years to reach its destination. Ten generations would be born and would die, and the eleventh generation would see the solar station at the end of the route.

In spite of this tremendous stretch of miles the sun, from our viewpoint, measured more than one-half a degree. This is equivalent to saying that the sun is a globe with a diameter of eight hundred and sixty-five thousand and four hundred miles, an area of two trillion and three hundred and fifty-four billions of square miles, and a volume of three hundred and forty quadrillions of cubic miles. In other words the sun is a globe of such stupendous dimensions that if it were hollow, it would contain one million and three hundred thousand worlds like our own. At first I was startled by such enormous magnitudes, which are far beyond the grasp of human comprehension; but this telescopic view closely followed up with mathematical demonstrations by Prof. Galvan led me to realize beyond the shadow of all doubt that the dimensions which are now attributed to the sun have not been exaggerated.

And what is still more wonderful is the fact that the entire surface of this tremendous globular mass, everywhere, is constantly overrun by sweeping floods of hot molten matter. The chromosphere composed largely of luminous, hydrogen gas is the seat of enormous protuberances and projections. Tongues of fire sometimes dart forth at the prodigious speed of one hundred and fifty miles a second to a distance of one hundred thou-

sand miles. These jets of hot molten matter sometimes make sharp angles with the horizontal plain, and at other times right angles; and, when the jets are vertical, the hot spray dropping back into the seething ocean of fire often takes the form of large trees and reminds the observer of a forest of *Sequoia Gigantea*. More often the hot descending spray of these great sun-storms, sweeping to the left and to the right, presents the appearance of stupendous prairie fires. (See Figs. 12, 13, 14, 15.)

With the exception of the meteoric bodies, the comets are by far the most numerous of all the heavenly bodies belonging to the solar system and are, without exception, the most fascinating. The suddenness with which they flame out in the sky, the enormous lengths of their trains, the swiftness of their flight, the strange and mysterious forms they assume, their unheralded advent and their departure for the profound depths of inter-stellar space—all seem to bid defiance to law and to partake of the marvelous. Every person on board the ship finally centered his interest on this particular class of heavenly bodies, and the sensation produced in every instant except in the cases of Capt. Ewald and Profs. Monahan, Galvan, and Rider, was the same—that of dread and loneliness. And Prof. Monahan, as if to excite the superstitious fears of all to a higher pitch, said:

“Comets have been looked upon in every age as—

Threatening the world with famine, plague, and war;

To all estates, inevitable losses;

To herdsmen, rot; to plowmen, hapless seasons;

To sailors, storms; to cities, civil treason; and

To us, they may be looked upon as—what?”

(See Figs. 2, 16, 17.)

The visible comets farthest away from the sun were mere faint diffused spots of light upon the dark background of the sky, while those near their perihelion distances were very large, exceedingly bright, and accompanied by long fan-like trains. They reminded me of mammoth bombs exploding, and I naturally wondered what hostile hosts of warriors at the outskirts of the universe were bombarding the sun.

At half past twelve o'clock I again directed my gaze toward the earth. Away to the west the more elevated parts of the great system of the Cordileras were heaving into view, and to the unaided eye the crests of the massive snow-capped ranges appeared as long white lines on the generally darker expanse of the continent.

At one o'clock we were five hundred and thirty miles above the surface of the earth and almost directly over Denver, Colo., which we readily located and recognized. We saw the long range of the Rocky Mountains in high relief go sweeping under us at a speed of nearly a thousand miles an hour, and by the aid of our small telescopes traced the channels of the larger western tributaries of the Mississippi river from their sources to their mouths; and at half past one o'clock we had a grand sweep of the whole Pacific coast from the Gulf of Lower California to the northern boundary of Washington.

This wonderful experience was truly the first and only one that ever brought me to so full a realization of what an immensely large object this old world is. When compared with infinite space she is, in volume, nothing more than a floating particle of dust or even a molecule; but, when viewed from an altitude of seven hundred miles, she is certainly a thing of magnitude. But when seen even from this great distance she does



FIG. 12. A SOLAR PROMINENCE.

This hot Jet extends vertically upward to a distance of eighty thousand miles. The spray falling back into the seething ocean of fire gives the whole the appearance of an isolated tree.

(Yerkes Observatory.)

not yet appear as a globe in the sky, but merely as a great convex circle with a constantly expanding circumference. At that time I did not realize that we were very far away from the earth, and comparatively we were not; for on a globe eight inches in diameter our altitude would be represented by only three-fifths of an inch.

Our first lunch in celestial space was served at half past one o'clock. At the close of this meal I was so sleepy that I could scarcely compel myself to stay awake. I was also very much fatigued—as much so as if I had been steadily engaged at manual labor for a whole day on the ten-hour system. My drowsy and weary condition was due partly to the fact that I had been steadily engaged almost the whole of the previous night at getting ready for the long voyage, and in part by the exciting influences of the weird and wondrous beauty to which I had, for the past two hours, been subjected, and which had steadily engaged my willing attention. I then prostrated myself upon one of the couches for sleep and repose.

CHAPTER VIII

THE FIRST DAY OF THE VOYAGE (Continued)

At half past eight o'clock p. m. I was aroused from sleep, partly by a sensation of cold from which I was suffering and in part by sharp, snapping sounds all about over the ship as if the walls and the dome were being pounded on the outside by small, scattering hail stones.

I glanced my eyes about the room and discovered that everybody had retired for sleep and repose except the captain, the electrician, our "family physician," and the colored man. Capt. Ewald was faithfully holding his position at the helm; Prof. Purnell was getting ready to start one of the large electric storage batteries for the purpose of furnishing heat for the physical comfort of the passengers and the crew, for preparing the evening meal, and with the further design of purifying and vitalizing the air pent up in the ship; Dr. Wharton was sitting near the helm, in a quiet conversation with the captain; and Dick Prouty was standing at one of the observation windows laughing and talking pretty loud, and comparing the sun to a large flower, and the comets near their perihelion distances to a swarm of bees gathering honey from it.

As soon as I was up and dressed, Dick called me to his side. I found his comparison to be a very apt one. The sun's great corona had arranged itself about this luminary in bands and cones of light in such manner as to give him the fancied appearance of a large, magnolia flower; and just at this time there were in the vicinity of the sun a great many small comets which had from one to three moderately long, bright, well-defined trains, and bore a considerable resemblance to bees. The nuclei or bodies of the comets represented the bodies of the bees, and the trains, their wings; and as the trains of comets always extend off in a direction opposite to that of the sun, these fancied bees seemed to be in the act of approaching the flower.

I was with Dick only a few seconds,—just long enough to get a glimpse of the sun and the comets on which he was exercising his fancy and to enter into his sympathy sufficiently to appreciate the comparison.

Shivering with cold and wondering where we were, I then hesitatingly approached Capt. Ewald and engaged him in a brief conversation.

"Captain, I am well clothed," said I, "but in spite of this fact I feel like I am freezing."

"I am not at all surprised," answered he, "for it has turned several degrees colder since we left St. Louis this morning."

"Captain, what makes the ship pop this way?" I inquired. "It seems to be in a rack all over."

"The maximum density, at which all substances naturally occupy the smallest amount of space possible," said he in reply, "is 39°, Fahrenheit; and the sharp, snapping sounds which you hear are due to the expansive force of the material in the walls and the

floor of the ship, caused by the intense cold on the outside."

"Captain, where are we now?" I then asked.

"In longitude 145° east of Greenwich," he replied, "and in latitude 37° north."

"Your reply is not altogether satisfactory," said I in response, "for I do not know yet where we are."

"Why do you not examine the registers and look all about you," inquired he very impatiently, "and try to determine the outside conditions and to locate yourself?"

I at once inspected the thermometer and found the record there 273° , Centigrade, below the freezing point of water. I then examined the barograph and discovered that we were soaring at an altitude of three thousand two hundred and fifty miles. I directed my eyes to earth again and observed that we were above a great expanse of water thickly studded with islands. After the lapse of a few minutes I discovered that our ship was almost directly above the meridian of Melbourne, Australia, and directly over Japan.

At this time I saw distinctly the whole continent of Australia and all the larger islands of the Philippine and Malaysian groups,—Borneo, Luzon, New Guinea, etc.,—sharply outlined by a lighter hue and readily recognized them all by their shapes and by their relative sizes and positions.

Their delineations correspond very closely with those of their maps found in our geographies, except that Australia and the large islands lying adjacent thereto seemed drawn-out from east to west, an appearance, the captain informed me, due to oblique and aerial perspective. I was able also to follow easily with my eyes

the trend of the whole eastern coast of Asia and to see inland almost to the Ural Mountains.

At three o'clock on the following morning we were directly over the Caspian Sea, were five thousand three hundred and eighty miles above the earth, and had an excellent view of all Eurasia, including Japan and the British Isles, of the whole of Africa, and of the island of Madagascar.

During the hour beginning with six o'clock in the morning the Iberian Peninsula went sweeping under us. At seven o'clock we sat down to breakfast. Just at this time our craft was seven thousand five hundred and thirty miles directly above Lisbon, Portugal, and was just launching itself out over the broad waters of the Atlantic. Except by the hour of the day as indicated by the faces of our clocks and watches we never knew whether to call a meal breakfast, dinner, or supper; for when one is wholly from under the rotary influence of the earth, his surroundings are the same at every hour of the day. That is to say there is no sunrise nor sunset, no night, but perpetual day with the sun constantly at the zenith.

At eleven o'clock we were almost on the border of the Western Continent. In the short space of four hours we had passed with almost absolute safety from the shores of Spain and Portugal to that of the United States. At any moment of this time I was able to view from limit to limit the same broad expanse of water which Columbus more than four hundred years ago was ten weeks in crossing at the peril of his life, and of which, in a sense, he saw comparatively little.

Almost before we were aware, it was twelve o'clock, noon. At this time we had been out on our voyage just twenty-four hours and had seen the earth, as a world

foreign to us, make one complete rotation upon her axis. Our distance from the earth was eight thousand six hundred and ninety-five miles; and in spite of this immense stretch of distance I was able, by the aid of a small telescope, to trace faintly the courses of the larger streams of the Mississippi system.

And according to the best means we had at hand for determining latitude and longitude, we were directly above a point on the earth's surface sixty-two miles almost due east of the city of St. Louis.

The earth, as a whole, no longer seemed to me merely as a great convex circle with a constantly dilating circumference, but appeared as a great globe lying in high relief, out in the heavens. I could see the whole of the American Continent in its full length and breadth—from Maine to California and from the Arctic Archipelago and the northern coast of Greenland to No Man's Land of Patagonia.

The earth truly presented a magnificent appearance, and was by far the most conspicuous and beautiful of all the planets.

It would be difficult to convey to the mind of anyone by means of words anything like a very correct idea of her size as she appeared to me. The members of our party differed widely in their opinions as to her dimensions. Some imagined her diameter to be somewhat less than one thousand feet, while others thought it to be anywhere from twelve hundred to fifteen hundred feet, and still others who gave it as their opinion that her diameter was no less than a half mile.

Perhaps Profs. Monahan and Galvan's reckoning on this point would be a more satisfactory presentation of the facts in the case. From our point of observation these learned men by means of mathematical and as-

tronomical instruments drew imaginary tangents to the circumference of one of the earth's great circles, and the divergence of these lines showed 36° , or one-tenth of a circle. In other words, the test exhibited that ten such disks as the earth presented, placed edge to edge, would form a belt around the celestial sphere, or that two and a half such disks so arranged with respect to one another would reach from a point in the horizon to the zenith.

As an object of beauty and intense interest the earth, as she presented herself to me at this time, would be a very difficult task for even the most imaginative mind to approach in the way of description.

Her atmosphere was almost entirely free from moisture; and although I was viewing this beautiful old world from a distance of approximately nine thousand miles, it was not difficult under such a condition for the unaided eye to easily observe in pretty sharp outline the contour of the continents, and by the aid of a small telescope to detect pretty easily the relief in the mountain chains and even in the chains of hills.

The face of the earth in general was almost the color of a bright-skinned orange and surrounded by a pale-blue border about eight feet broad.

At other times, when the atmosphere was pretty generally laden with moisture, the earth appeared to be enveloped in a mantle of mist or vapor varying in hue from a deep gold color to that of almost a fleecy whiteness. And in spite of the fact that the earth shrank away in size as we steadily approached the moon, I was able, under the most favorable atmospheric conditions, at any time during our transits, to trace with my eyes the delineations or the outlines of the continents and of the larger islands, without the aid of the telescope.

CHAPTER IX

PERILS IMAGINARY AND REAL

The captain steered with a steady hand, and onward our craft went, day after day, at the uniform speed of three hundred and fifty-five miles an hour, through the changeless, trackless, and limitless calm, and all the while it ran perfectly steady except that just now and then I felt a slight tremor or a gentle tilt.

In spite of the fact that the monotony was great, no one became restless, impatient, or despondent for several days, because our surroundings in general were attended with things of wondrous beauty upon which to gaze and about which to think.

The extreme silence that prevailed was awful. Not a sound was to be heard in the whole universe during the entire voyage except a weak, but energetic fizzing and clicking of delicate but strong machinery in three small boxes,—one at each end of the sitting room and another at the highest point of the ceiling—and the occasional sound of a low, weak, human voice.

At noon on November 29, when we had been out on the voyage just a week, several of the members of our party were violently seized with a panic which, in a sense, came very near ending disastrously. I, for one, was stricken with fear and was frightened almost out of my wits, yet I am not able to state any assignable

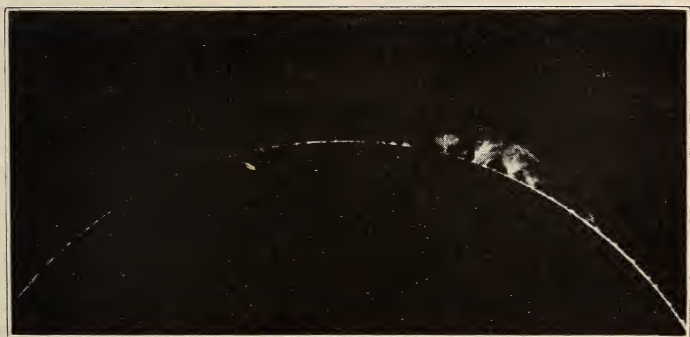


FIG. 13. SOLAR PROMINENCES SHOWING CURRENTS
IN DIFFERENT DIRECTIONS.

(Yerkes Observatory.)

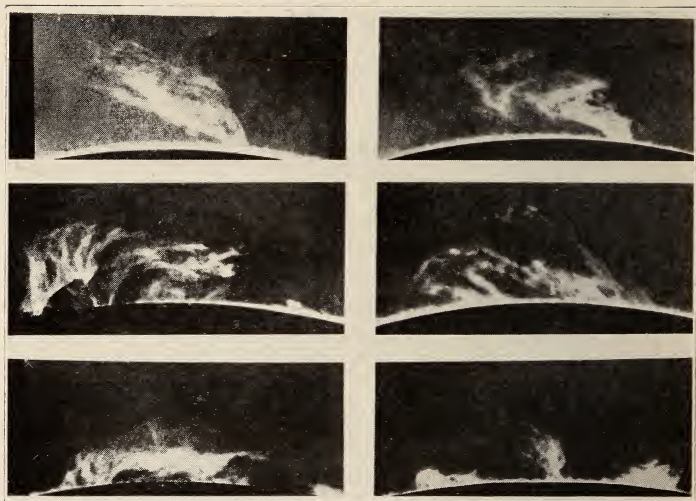


FIG. 14. SOLAR PROMINENCES SHOWING CURRENTS
IN DIFFERENT DIRECTIONS.

More often the hot descending spray of these great sun storms, sweeping to the left and to the right, presents the appearance of stupendous prairie fires.

(Yerkes Observatory.)

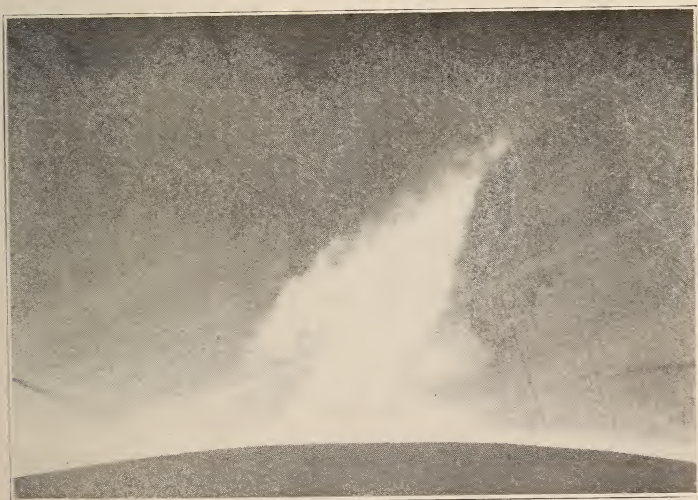


FIG. 15. SOLAR PROMINENCE SHOWING CHANGES.
(Yerkes Observatory.)



FIG. 16. GIACOBINI'S COMET, 1908.

(Yerkes Observatory.)

reasons for the general alarm. The most satisfactory explanation that I can give is that some one became frightened at what he thought was immediate danger, and the emotion of fear rapidly spread from one to another until about half the members of the party were almost terrorized out of their senses. Within two or three days I realized that this sense of fear was truly inspired by trifling causes or misapprehensions of danger.

We had just finished our noon lunch and, as usual, immediately after meals, were sitting in our easy chairs engaged in an all-round, quiet conversation. It was clearly manifest that even at this time the newness of things about us was beginning to wane, at least in the cases of a few, and that time was dragging a little—sufficiently to allow the minds of those with slightly idle tendencies to multiply, magnify, and play upon imaginary dangers along the way.

The conversation finally ceased entirely for a few minutes, when Mr. Waite suddenly rose from his seat, gave a gentle but restless sigh, and walked straightway to the registers. He first inspected the thermometer and then examined the barograph. After gazing steadily for perhaps two minutes at the alarming records he found there, he turned suddenly and restlessly away and resumed his seat. His lips were white and his face was pale and without expression. After a short interval he addressed all present as follows:

“Gentlemen, I seriously regret that I ever ventured to go on this voyage.”

“Why so, Frank?” inquired Prof. Galvan in great surprise.

“Because I do not believe we shall ever be able to reach destination,” replied Mr. Waite nervously, “for

we are now fifty-nine thousand eight hundred and fifteen miles from the earth and farther from the moon than we were the day of our departure."

"That is right, Frank," interrupted Prof. Brunor, "and besides, the moon has moved more than 90° from west to east upon her orbit."

"Well, if we never get to the moon, we can go back home again," said Prof. Purnell humorously, "if we don't joy-ride around up here in the sky until our food supplies give out or the batteries become discharged."

"I feel no uneasiness about our provisions running low, but what would be the immediate and final result," inquired Mr. Waite, "if the batteries should become exhausted, or if they should for any cause whatever fail to perform their work?"

"We would freeze to death, or perish from breathing carbon-dioxide," replied Prof. Purnell, "within twenty-four hours."

"How did the thermometer on the outside stand, Frank, when you examined it a few minutes ago?" asked Mr. Vanderlip.

"The record there was 273° , Centigrade, below the freezing point of water," replied Mr. Waite.

"We could not survive long," interrupted Prof. Monahan, "if we had no means of furnishing heat and absorbing carbon-dioxide."

"Do you suppose there is any likelihood," inquired Mr. Shipley, "of the batteries becoming exhausted or of their going dead?"

"Such a thing is possible," replied Prof. Purnell, "but not at all probable. You understand that one of these batteries will enable us to live sealed up in this room a hundred days; and besides, we have two more charged

batteries sitting there idle and ready for use when the need demands it."

"Prof. Rider, has the ship changed her course?" inquired Mr. Vanderlip.

"No; the moon will have to revolve entirely around the sky, and therefore about the earth," replied he, "before we shall be able to reach destination. One week from today the moon will be almost directly beyond the earth from us, and one hundred and twenty thousand miles farther away from us than she was on the day of our departure; and in three weeks from now she will be directly in front of us and by that star to which the ship was gauged at the beginning of the voyage."

"And where will the ship then be?" inquired Mr. Vanderlip.

"The ship will be there too," replied Prof. Rider, "if we hold steadily to our present course and keep up the limit of our speed, which is three hundred and fifty-five miles an hour."

"How fast does the moon travel in her orbit?" asked Prof. Knowlton.

"Two thousand one hundred and sixty miles an hour is her average speed," replied Prof. Galvan.

"In my opinion it is very little that any one knows," interrupted Mr. Waite, "where the moon will be when we are due to land. I don't believe anybody knows the distance from the earth to the moon, no way, nor how fast she travels upon her orbit."

"Why, Frank, have you no confidence in figures nor faith in astronomical science?" exclaimed Prof. Monahan in great surprise. "Listen, Frank," continued he, "and let me briefly explain to you a matter in mathematics: if lines be drawn from the extremities of one

of the earth's diameters to a point indicating the center of the moon's disk, a triangle will be formed, of which one side and two angles will be known. With these data the distance to the moon may readily be computed. In fact this is one of the simplest calculations in trigonometry with which the astronomer has to deal. And the distance to the moon being known, any school boy or school girl can easily determine the diameter and the circumference of the moon's orbit, and her speed through space."

"Yes, and it is my candid opinion," said Prof. Thor- sen, "that when we attempt to land on the moon while she moves at the terrific speed of more than two thousand miles an hour, our ship and contents will be knocked into smithereens or dissolved into molecules."

"Troubles borrowed from this source," replied Prof. Monahan, "are imaginary ones. In March of 1912 Capt. Ewald visited Prof. Galvan and me at our homes in Dublin, with the express purpose of discussing with us the law of falling bodies, with a view to inducing us to make this voyage with him and to effecting this very landing. After several days of very close and careful investigation we proved, even beyond the shadow of all doubt, that such a landing could easily and safely be made; and in three weeks from now you shall witness a practical demonstration of this fact."

"I hope you, Profs. Galvan and Rider, and Capt. Ewald understand your business," replied Prof. Thor- sen, "but my faith is like Frank's—a little shaky."

I too was terrorized almost out of my senses, but tried to keep silent. I came to regard all speculation with indescribable terror or as the presage of some impending calamity, and felt sure that somehow or in some way we should all be totally and forever lost, so

far as the present life is concerned, in the immeasurable depths of trackless space.

I longed for a solid foundation upon which once more to place my feet, but nothing of this kind was within reach. I saw hundreds of planets, which resembled billiard balls racing with one another through the sky, but they were at distances so immense that the strongest intellect or even the brightest imagination in its effort to grasp them would have collapsed weakly before them. And the awful void about us made me feel that our ship was surely and steadily shrinking away to a mere point. I felt that our lives were hanging on a thread; and my full realization of the fact that our destiny was in the hands of one, self-willed man who possessed unbounded confidence in himself and who was not, in the least, compliant with the wishes of anyone else, made the situation appear to me all the more alarming.

Finally a petition to turn back, with a half dozen names to it, was handed to the captain, at which he only smiled, and to which he gave no response. On the following morning those who had risen in opposition to authority called Prof. Rider to one side and asked him if he would steer the ship home if they threw Capt. Ewald overboard. To this question he refused to make reply, but he began at once to look into the matter. Dr. Wharton then advised and urged the captain to give the mutineers some wholesome instruction, entertainment, or amusement, in order to allay their fears and to prevent, if possible, any serious disaster.

CHAPTER X

PERILS IMAGINARY AND REAL— (Continued)

Early on the following morning, after two more square meals and eight hours of sleep unrefreshing to a number of us, Capt. Ewald, for the entertainment of all, and especially for the instruction and the amusement of those who had attempted to destroy due subordination to authority, asked that some one volunteer to discuss the law of universal gravitation and some formulae based thereon and relating directly to falling bodies. The work was at once taken up; and the captain, during a pause in the discussion, cast two of the pigeons and the gander into the boundless deep.

Promptly at the call for a volunteer to discuss the questions at hand Prof. Daniel C. Monahan, the learned mathematician and astronomer, ripe in years of experience, came quietly forward holding in his right hand a pointer and carrying on his left arm a number of large, heavy, cardboards bearing some diagrams, the statement and the solution of an algebraic equation, and some formulae.

After politely requesting all to be seated this grand man took a standing position in front of his small but appreciative audience, made an earnest appeal for undivided attention, and then spoke as follows:

"Gentlemen, I desire to discuss briefly before you this morning the law of universal gravitation and some formulae based thereon and relating directly to the law of falling bodies.

"These inquiries are not by any means difficult; and, for soliciting and urging your riveted attention to, and your careful consideration of, questions which to mathematicians of some repute appear quite simple, and for thus seeming to recognize you as being stupid or ignorant, it is both proper and in place that I should offer a slight apology, or at least an explanation.

"Truly I realize that you, whom it is my honor and pleasure to address, constitute an intelligent body and that you, as individual members of that body, assembled here for the common purpose of receiving such instruction as I on this occasion may be able to impart, are not only men of more than ordinary natural ability to understand, but college-bred men as well. Therefore, I do not presume that any one of you is totally or even in part ignorant of the questions at hand. Rather, I think it most probable that every one of you either is or has been familiar with the points to be emphasized. But because the clear understanding of the matter which I wish finally to present to you depends largely upon your perfect familiarity with the things about which I am going to talk first, I again insist that you give me audience and follow me closely in the discussion of the law and in the substitution of the known numerical values for the literal quantities found in these formulae.

"The law of universal gravitation as announced by the great mathematician and astronomer, Sir Isaac Newton, reads as follows:

“‘Every particle of matter in the universe attracts every other particle of matter with a force directly proportional to the product of their masses and decreasing as the square of the distance between them increases.’

“And it follows from the wording of this law that somewhere in the straight line connecting the centers of any two heavenly bodies there is a particular point at which if any object of space be set free to move in obedience to the natural forces exerted upon it, this matter would remain afloat, or on a balance, so to speak; that is, it would be as much inclined to move in the one direction as in the other. This point is called the **point of equilibrium**. And after you have followed me closely through this discussion, the underlying principles by which the location of such point is in every instance mathematically determined will be clear to your minds.

“But let us see if we understand the wording of the law, in order that we may lead up to the conclusion intelligently.

“In the statement of the law the word ‘particle’ does not necessarily mean molecule, but simply a quantity of matter so small that all points of it may be considered as being at the same distance from an attracting body. In the case of spheres the bodies may be of any size whatever, if all the matter be regarded as concentrated at their centers.

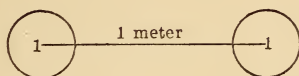
“The pull or the attractive force that two bodies exert upon each other depends upon two things—the inherent attractive capacity of the matter they contain, and the distance by which they are separated. First, let us examine the law so far as it relates to the inherent attractive capacity of matter, which depends solely upon its mass.



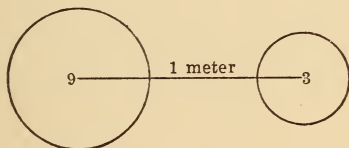
FIG. 17. MOREHOUSE COMET, 1908.

(Yerkes Observatory.)

“Two spheres weighing one gram each, at a given distance apart, attract each other with a certain amount of force. If the mass of one of the spheres be increased



to nine grams and that of the other to three grams, the force exerted by them will, according to the law, be twenty-seven times as great. It is easy to understand that the force must be proportional to the product of their masses. Since there are nine grams in one mass



and three in the other, each of the nine grams of the first attracts each of the three grams of the second; or, each of the three grams of the second attracts each of the nine grams of the first. The total force exerted must, therefore, be twenty-seven times as great as that with which one gram attracts another gram at the same distance.

“From the data herein contained is derived the direct proportion,

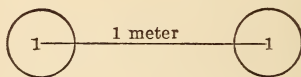
Latter Pull : Former Pull :: 9×3 : 1×1 , or :: 27 : 1,

which is equivalent to saying that the pull or force

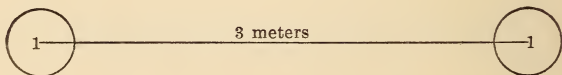
exerted by the two larger spheres on each other bears the same ratio to that put forth by the two smaller spheres that 27 bears to 1, and which exemplifies that part of the law which says, 'Every paricle of matter in the universe attracts every other particle of matter with a force directly proportional to the product of their masses.'

"As previously stated, the force that any two bodies exert upon each other depends upon two things—the inwrought attractive capacity of the matter they contain, and the distance by which they are separated. Up to this point in the discussion we have dealt with the inherent or innate attractive capacity of matter which depends solely upon its mass. Now let us take up the question of the law so far as it relates to the distance by which the attracting bodies are separated.

"Two spheres weighing one gram each, placed at a distance of one meter apart, attract each other with a



certain amount of force. Now if the spheres be separated from each other by a distance of **three** meters, the force exerted by them upon each other will be only

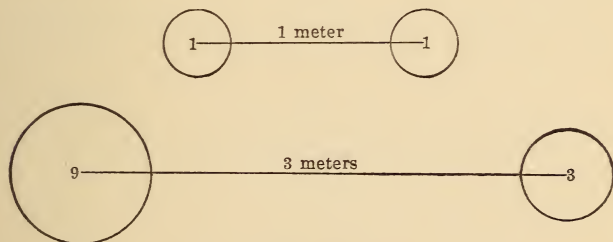


one-ninth as great. From the data arising from the above assumed condition is derived the inverse proportion,

Latter Pull : Former Pull :: $1^2 : 3^2$, or :: 1 : 9,

which illustrates that part of the law which reads, 'Every particle of matter in the universe attracts every other particle of matter with a force decreasing as the square of the distance between them increases.'

"Now examine the following figure and note that unlike either of the two foregoing illustrative diagrams it involves completely both elements of the law, one of which relates to the pull of two bodies upon each other due to their inherent attractive capacities, and, the other to the force exerted by them upon each other due to the distance by which they are separated. The data herein contained give rise to the proportion.



Latter Pull : Former Pull :: $27 \times 1 : 1 \times 9$, or :: 3 : 1.

"This proportion is obtained by multiplying together the corresponding terms of the two foregoing proportions, and is equivalent to saying that the force exerted by the nine-gram sphere and the three-gram sphere upon each other at a distance apart of three meters bears the same ratio to the pull of the two one-gram spheres at a distance apart of one meter that 3 bears to 1.

"This last proportion together with the accompanying illustrative diagram contains everything found in the two foregoing ones and sets forth or exemplifies at once completely the whole law.

"We will now discuss the law, taking into consideration, this time, that there is an intervening mass upon which the attracting bodies are exerting their influences.

"Let A and B in the accompanying diagram represent any two heavenly bodies of equal mass, distant from each other any number of astronomical units for measuring celestial distances, and let C be a third object of space, of any mass whatever, located at the midway point of the straight line connecting their centers. And let M symbolize the masses of A and B, and m that of C.

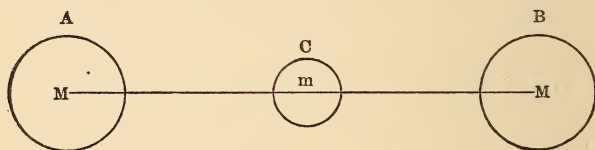


Figure 1

"Under the conditions assumed the forces exerted by A and B on C are equal. As a result, these bodies exerting their forces upon the intervening mass in opposite directions counteract them and thereby fix the point of equilibrium at the middle of the straight line that measures the distance between their centers.

"As a further consideration of the inherent attractive capacity of matter, let us suppose that the mass of A has been increased to four times its original mass while that of B remains unchanged.

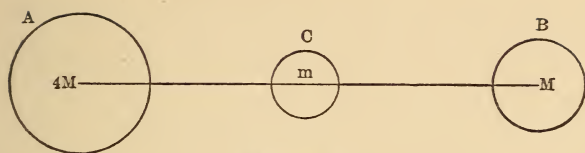


Figure 2

“Under this supposition it is clear that the pull of A on C is four times as great as that of B on C and that the point of equilibrium lies somewhere in the direct line connecting the centers of B and C, because the inwrought attractive capacities of any two bodies are directly proportional to the product of their masses. This gives rise, in this case to the direct proportion,

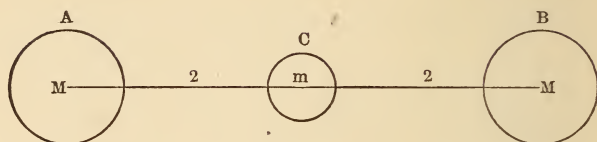
Pull of A on C : Pull of B on C :: $4Mm$: Mm , or :: 4 : 1.

“By means of the two foregoing illustrative diagrams I have set forth before your minds, in a clear light, no doubt, only that part of the law which relates to the innate attractive capacity of matter, which depends solely upon its mass; but this inwrought capacity of matter is not the only thing with which the law is concerned.

“We know that the force of attraction, or the pull of matter, varies with the increase or the decrease of distance and that this variation is in an inverse ratio to the square of the distance.

“Let us assume the conditions set forth in connection with Fig. 1, and suppose A and B to be four astrono-

mical units apart. As the mass of A is equal to that



of B, and as C lies equally distant from them, the forces exerted by them upon the intervening body counteract each other and establish the point of equilibrium at C.

“Now if C be brought twice as near B, the force of B’s attraction upon it becomes **four** times as great as before, **four** being the square of **two**. B’s inherent attractive capacity, which depends solely upon its mass, or quantity of matter, remains the same; but the force of the attraction, or the pull, is increased because of the decrease of distance. At the same time A’s pull upon C is diminished according to the same law and

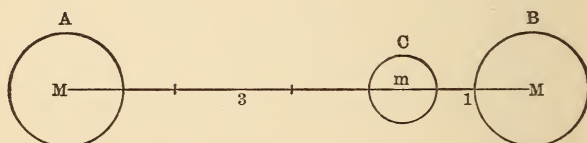
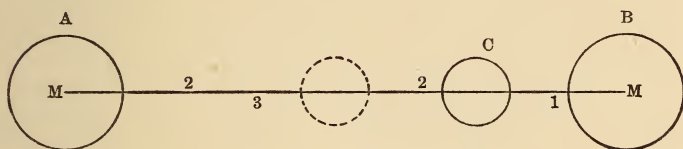


Figure 3

becomes only **four-ninths** of what it was before, **four-ninths** being the square of **two-thirds**. Dividing 4 by $\frac{4}{9}$ we obtain 9, which shows that **measured by the effect of distance alone**, B’s attraction on C has become nine times that of A’s.

“The discussion on this particular point has not placed the matter in a clear light? Well, then, we will go over the work again with different illustrations.

“Now let us first condense the two foregoing illustrations, together with their data, into one illustrative diagram, as follows:



“You understand that B has two pulls on C—one while C is at a distance of two astronomical units, and another while at a distance of one astronomical unit. From these data is derived the inverse proportion,

Latter Pull of B on C : Former Pull of B on C :: $2^2 : 1^2$,
or :: 4 : 1 = 4.

In other words, the attractive force exerted by B on C at a distance of one astronomical unit is four times as great as that exerted by B on C at a distance of two astronomical units.

“It is true also that A has two pulls on C—one while C is at a distance of two astronomical units, and another while at a distance of three astronomical units. From the data here given arises the inverse proportion,

Latter Pull of A on C : Former Pull of A on C :: $2^2 : 3^2$,
or :: 4 : 9 = 4/9.

This is saying that the attractive force exerted by A on C at a distance of three astronomical units is only four-ninths as great as that exerted by A on C at a distance of two astronomical units.

“Now dividing 4, the result obtained from the first of the two foregoing proportions, by $4/9$, the answer acquired from the second, we get 9 for a quotient. This shows that the pull of B on C at a distance of one unit is nine times as great as that of A on C at a distance of three units.

“But as the assumption is that A and B are equal in mass and therefore possess the attractive property in the same degree, the foregoing final result, 9, may be obtained at once and direct by embodying the two proportions in one, thus:

Pull of B on C : Pull of A on C :: $3^2 : 1^2$, or :: 9 ; 1 = 9.

“Now according to the assumed conditions which result in the three foregoing inverse proportions we must, in order to counteract the forces exerted by A and B on C and thereby establish the point of equilibrium at a distance of three units from A, increase the mass of A by nine times its former mass.

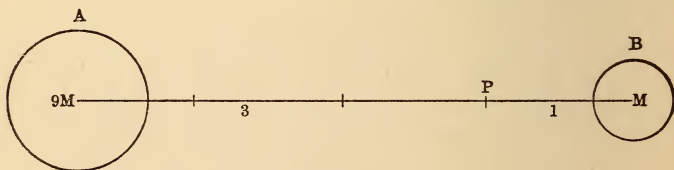


Fig. 5.

This gives rise to a proportion of another nature—the direct proportion,

$$9M : M :: 3^2 : 1^2, \text{ or } 9 : 1,$$

which is not out of harmony with the law, and which



FIG. 18. STAR CLUSTER.

(Yerkes Observatory.)



FIG. 19. STAR CLUSTER.

(Yerkes Observatory.)



FIG. 20. GREAT NEBULA IN ANDROMEDA.

(Yerkes Observatory.)

from which we readily deduce the equation,

$$\frac{81M}{x^2} = \frac{M}{(240000-x)^2}$$

which, when solved, gives for results

$$\begin{aligned} x &= 216000 \\ 240000-x &= 24000 \end{aligned}$$

“According to Newton’s law a point of equilibrium exists somewhere in the direct line connecting the centers of any two heavenly bodies whether they be planets, comets, meteors, or fixed stars. And such a point inserts itself, or rather exists, in the straight line connecting the centers of any two bodies whether they be in a position of permanent rest, suspended by means of cords in mid-air, or in a state of motion as when cast off into free space.

“At the present time the parts of the ship’s running gear are adjusted for an ethereal flight. As a result, no influence whatever is exerted by the heavenly bodies upon the craft. By virtue of the mysterious running gear of our craft all relation or connection between the ship and any and all foreign matter, so far as attractive capacity of matter is concerned, is severed. The law of universal gravitation has, so far as we are now concerned, ceased to exist; and, as a result, the ship floats in inter-stellar space as lazily and quietly as an inflated balloon in an airflight.

“By a displacement of the parts of this machinery the power of universal attraction would be liberated, or practically called into action. As a result, a point

of equilibrium would insert itself in every straight line connecting the ship's center of gravity with those of all foreign bodies, and the craft would at once respond noticeably to the most powerful influence exerted upon it, and in strict obedience to the law of universal gravitation fall away in that direction at a constantly increasing rate of speed until the two bodies came together with tremendous force."

CHAPTER XI

PERILS IMAGINARY AND REAL— (Continued)

Just as Prof. Monahan concluded the last sentence he smiled, made a slight bow, and took his seat. Then Capt. Ewald rose to his feet, signaled to the colored man to bring on the fowls, and said:

“Now, gentlemen, we are going to cast out two of the pigeons and the gander into the limitless abyss about us; and, as by virtue of the proper adjustment of the ship’s running gear the power of attraction between the craft and all foreign matter is completely severed, the birds will descend to the earth unchecked by any force behind them with steadily-increasing velocity.”

Just as the captain was concluding this utterance, Dick Prouty came forward wagging the coop.

With his own hands Capt. Ewald himself promptly and quickly placed the pigeons and the gander into the big steel pipe, closed the door, and fastened it with the band ring. He then took hold of the lever, quickly faced about and exclaimed:

“Ready!”

We at once fell upon our faces to peer through the panes of glass set in the floor of the ship. By the

time we were in a position to observe, the captain pulled the lever to turn on the compressed air from the dome and at the same time said:

"Now fly your way home."

Out the fowls went with considerable force but unharmed, to be sure, as there was neither atmosphere nor any other matter on the outside to offer them resistance and thereby to do them violence.

The pigeons were very dark, and owing to the slight contrast between their color and that of the heavens about us I did not, after a few seconds, see them any more; but I saw the gander all the while as plainly as if he had been a big wad of cotton up against a freshly-painted blackboard only a few feet away.

After he had fallen perhaps a distance of three hundred yards he appeared to be not more than fifty feet beneath the floor of the ship. Why, I could distinctly discern his every movement; and even see his eyes, his toe-nails, and his nostrils—my vision was so clear.

This brave old bird, when he discovered that he had been liberated, at once coiled his neck about his crop, threw his head far back over his body, and flapped his wings almost as rapidly as a humming bird. For some time he appeared to remain just beneath the ship, and seemed to be suffering intensely from cold and to be struggling hard for breath. Presently he began to fall behind the ship; and, as there was not any atmosphere about him to offer his wings resistance, it was clear to be seen that his efforts to propel himself by means of his strength were futile.

At the expiration of seven minutes, when I last saw the gander, he had descended a distance of five hundred

and thirty-four miles and acquired a velocity of two and a half miles a second. At this time he appeared to me no larger than a man's thumb and resembled a large snow flake away out against the dark background of the sky in the direction of the earth. He was slowly rotating end over end; and I am sure he was dead, for he looked limp. He reached the aerial region of the earth in one hour and nineteen minutes at which time he had acquired a velocity of twenty-nine miles a second, a speed so immense that the resistance offered by the earth's atmosphere must have set him ablaze all over; and, by the time he reached the surface he was evidently a "cooked goose."

Perhaps it may not appear reasonable that we could distinctly see the gander at the distance of five hundred and thirty-four miles, yet it was true. Really the distance was five hundred and seventy-six miles, for during the seven minutes we were watching him in his descent, our ship had advanced in its course forty-two miles. It is truly wonderful how clear one's vision is where there is no atmosphere laden with vapor, smoke and dust to obstruct the view.

After the gander had disappeared in the depth of space Prof. Monahan quickly reappeared in front of his audience. After demanding attention he turned a large card-board, thereby exposing to view four formulae relating directly to the law of falling bodies.

$$(1) \\ S = 16 T^2.$$

$$(2) \\ V = 32 T.$$

$$(3) \\ T = \frac{1}{4} \sqrt{S}$$

$$(4) \\ V = 8 \sqrt{S}$$

"Please direct your attention this way again," said Prof. Monahan, "for I have something of unusual interest to tell you, which is well worth your time to consider. These formulae," he continued, "in which S represents the space moved in feet, T the time in seconds, and V the velocity in feet per second acquired in falling S feet, or in falling T seconds, will enable you to find out anything you should desire to know about the fowls—their distance from their position of rest from which they were hurled, the time required in falling any given distance, and their velocity at any given time. Now ask any questions you wish, and by means of these formulae I shall take pleasure in giving you the desired information."

"How far will the birds have fallen," asked Prof. Thorsen, "in one hour from the time they were cast out of the ship?"

"The time is 1 hr., or 3600 sc.," answered Prof. Monahan, "and substituting this numerical value for T in the first formula shown above we have,

$$S = 16 T^2 = 16 \times 3600 \times 3600 = 207360000 \text{ ft., or } 39272 \text{ mi.}"$$

"How do you determine the length of time," inquired Prof. Purnell, "the fowls will be in reaching the earth?"

"The space to be passed over in this case is 68160 mi., or 359884800 ft.," replied Prof. Monahan, "and substituting this numerical value in the third formula we have,

$$T = \frac{1}{4} \sqrt{S} = \frac{1}{4} \sqrt{359884800} = 4742 \text{ sec., or } 1 \text{ hr. } 19 \text{ min.}"$$

"What will be the velocity of these birds per second," asked Mr. Vanderlip, "when they reach the earth?"

"The time is 1 hr. 19 min., or 4742 sec.," came the prompt reply, "and substituting this value in the second formula we have,

$$V = 32 T = 32 \times 4742 = 151744 \text{ ft., or } 29 \text{ mi.}"$$

"The velocity per second may be found also," continued Prof. Monahan, "by substituting the space passed over in feet, in the fourth formula. Thus:

$$V = 8\sqrt{359884800} = 151760 \text{ ft., or } 29 \text{ mi.}"$$

"Will these formulae hold good," inquired Mr. Shipley, "in cases of any or all falling bodies regardless of their masses or their density?"

"A cannon ball, a piece of cork, and a feather started from the same place and at the same time, from a position of rest," came the response, "would reach the earth's surface at the same time. All falling bodies, regardless of mass or density, obey the same law when descending in a vacuum."

"I have no inclination to want to ask unnecessary questions," interrupted Mr. Vanderlip, "but what is a vacuum?"

"A vacuum," responded Prof. Monahan, "is unoccupied space—space in which there is not even the vestige of air. Celestial or inter-stellar space is a great natural vacuum."

For more than an hour, perhaps, we were steadily engaged at either asking questions, or at light exercises in mathematics, in which all took part.



FIG 22. TRIFID NEBULA IN SAGITARIUS.

(Yerkes Observatory.)

And it is wonderful what a wholesome effect these exercises produced. All the fears of those who the day before refused to subordinate themselves to authority vanished, and not a word was again said in regard to returning home.

This day of trouble was Nov. 29th. The dangers were only imaginary ones, and really there was not the slightest grounds for any of this alarm.

But on Dec. 2, just three days later, grave dangers unlooked for and unthought-of did arise on every side.

It was five o'clock in the afternoon. Capt. Ewald was at the steering wheel and the craft was heaving silently onward at the limit of its speed. Most of the party were quietly sitting in the chairs and seemed at this time to be in a dreamy or meditative mood. Prof. Galvan was star-gazing and I was at his side gaining such astronomical knowledge as I could by observation and by asking questions.

Presently I observed that something unusual in the sky was holding his attention fixed. He finally ceased to give any heed to my questions and rapidly began to make observations in every conceivable direction. After his attention had been closely engaged for some thirty minutes he briskly tapped me on the shoulder, commanded me to go with him, and walked hastily to the helm where Capt. Ewald was engaged with Prof. Rider in a quiet conversation.

"Captain, I have no inclination whatever to want to excite further alarm," said Prof. Galvan, "but we are now truly in imminent and unavoidable danger."

"What is it?" quickly asked the captain with a look indicating a mild degree of surprise.

"We are in a shoal of meteoric bodies and a cloud of star-dust," replied Prof. Galvan. "I can see some of the larger ones of those more remote without the aid of the telescope."

"Whatever else you may do or say," responded the captain, cutting his eyes fiercely and rapidly first at me and then at Prof. Rider, "please do not make any mention of this discovery to any one else during this voyage. We have had trouble enough like that which such publication might bring."

"I have studied astronomy a little," said Prof. Rider, "but I am not able to call to mind just what meteoric bodies are."

"Meteoric bodies or stones are truly little worlds varying in diameter from a half inch to several feet," replied Prof. Galvan, "and varying in weight from a few ounces to several tons. Like the planets, they are globular in form, obey the law of gravitation, and revolve around the sun in regular periods of time."

"Millions of this class of heavenly bodies come in contact with the earth daily," interrupted the captain, "and as they sweep through the atmosphere the friction partly arrests their motion and converts them into heat and light. They are then called meteors and may be seen in great numbers at night. As there is no atmosphere far out in space where we are, to offer them resistance, they are not self-luminous and can be seen only by the reflected light of the sun."

"I cannot understand," said Prof. Rider inquiringly and with some degree of emphasis, "how these meteoric bodies could harm us in the least."

"These little planets travel at a speed of more than twenty-five miles a second," the captain replied, "and

if one of these worlds in miniature weighing about a ton should strike our ship, you would perhaps know how much harm they are capable of doing."

"Well, what is star-dust?" then inquired I.

"Star-dust," interrupted Prof. Galvan, "is a cloud of meteoric stones ranging in size from that of a wild grape to that of a billiard ball."

"Now tell me, if you please," said Prof. Rider, "how these wee things could do us any harm."

"Burwell, the force of a discharge from a machine gun would be feeble in comparison with that with which these treacherous little worlds would strike our ship," replied Prof. Galvan, "if it were to get in their path. The observation windows, which are ten inches thick, could no more resist them, traveling at this incredible speed, than an ordinary pane of glass could resist the discharge from a Springfield rifle."

In about three days the danger seemed to be over. After their disappearance the astronomers said that they expected our ship to be struck at any moment by one of these travelers of the sky, and dissolved to molecules and scattered in space, to be picked up in piece-meals during subsequent periods by passing planets, meteoric bodies and comets.

CHAPTER XII

PERPLEXING EXPERIENCES

These worlds in miniature from the largest to the smallest, revolve individually around the sun, but myriads of them follow the same orbit and therefore travel in the same direction.

On account of their volumes and their masses the larger of this order of heavenly bodies deserve to be classed as minor, primary planets, rather than as meteoric bodies. I observed scores of them whose diameters range from one hundred to three hundred feet and which, when seen at distances ranging from one hundred to seven hundred miles, appeared to vary in size from that of an orange to that of a foot-ball and were distinctly visible as they rapidly defiled along the sky in great numbers. I could not hear them, because there was no intervening element to offer them resistance and thereby to conduct sound, nor could I see those that passed very near the ship on account of the extreme swiftness of their flight.

These that went by on the side opposite the sun were of a bright-orange color, while those that passed between us and the sun were in color a steel-gray and bounded around by threads or narrow zones of dull-red light produced by the sun shining beyond the lines of illumination.

Some seemed to be traveling much faster than others, but this was an optical illusion due to the differences in distances from our point of observation.

In spite of the fact that our craft was steadily and rapidly moving onward, it appeared to me that we were constantly at the center of a great hollow globe. This globe seemed to be bounded by a shell as black as night, thickly studded with innumerable glittering points of light and splashed over with almost countless patches of luminous clouds of a fleecy whiteness.

These little wanderers of the sky appeared to be surging through a hole in this great shell, known in astronomy as the "radiant point," passing around us on semi-circles, and disappearing through a hole on the opposite side of the hollow globe. In other words, they seemed to enter the celestial sphere at one of its poles, to trace its meridians, and to pass out and from sight through the opposite pole. But this particular maneuver common to all the meteoric bodies was an optical illusion—they were moving in essentially parallel lines. On this same principle the railings of a car-line appear to converge to a point both ways as one looks up and down the track. The same illusion is seen, if looking upward, we watch snowflakes falling during a calm. Those coming directly toward our eyes seem to be motionless, and the rest to separate from them in diverging lines.

I was constantly bewildered and distressed by the fact that I was not able by means of any visible and tangible objects in the sky to locate myself. Everything about us was direction, yet not any course along which I fixed my gaze seemed to be any one of the

points of the compass nor any other absolute course with which I had ever been familiar on earth.

When the atmosphere was free from clouds and vapor, I could look back to earth and readily and easily get the lay of the continents, and thereby determine the points of the compass; but after they had thus been located, they did not often seem to be the directions they really were. And if the cardinal points as indicated by the positions of the continents happened for a moment to appear real, the very instant I directed my gaze away from earth and into the heavens, I was again at sea as to positive knowledge and consciousness of absolute directions.

Every thing in the visible universe seemed to readily adjust itself to my imagination.

Sometimes I tried to fancy some particular direction along an imaginary horizontal plain to be some particular point of the compass; and on looking in the direction of the earth for the verification of my fancy, it would appear that this old ball had suddenly revolved from one-fourth to one-half around upon one of her imaginary equatorial diameters and that the course under consideration was at variance with that of the compass by from 90° to 180° .

I sometimes directed my eyes toward some star of the first or of the second magnitude and tried to imagine the course to be some particular direction with which I was familiar on earth, and frequently after a few seconds, the course would seem to be the direction I supposed it to be; but the very moment I imagined the course to be some other direction, the whole stellar world would at once apparently adjust itself to my fancy. And usually as often as I repeated this experi-

ment, the celestial vault would appear to revolve in the twinkling of an eye upon the celestial diameter that would most readily accommodate it to my imagination.

My attention was first directed to this strange phenomenon when we were in the shoal of meteoric stones. On one occasion I was standing at one of the observation windows steadily peering through the pane away on an imaginary horizontal plain at the wee planets as they seemed to be surging through a hole in the great hollow shell that inclosed us, and diverging to pass around us on every side. I just imagined what a pretty, awe-inspiring sight it would be if the radiant point were directly over head; and at that very instant the whole concave of the sky adapted itself to my fancy, and then the ship appeared to be gently resting upon its side, and the swarm of little worlds seemed to be entering the hollow sphere at the zenith and falling rapidly down the sky on all sides of us in the manner of rain drops chasing one another down the ribs of an umbrella spread above me.

These miniature worlds often seemed to cease suddenly their flight and at the same moment our craft appeared to sheer off in the direction of the radiant point, at which they were apparently emanating, at the speed of meteors. After a few seconds the craft would as suddenly seem to stop, and the meteoric stones to simultaneously take up their flight again. You witnessed a similar phenomenon when you fancied your train was moving, while it was merely another train on a side track beginning to move in the opposite direction.

I became so confused by these and similar perplexing experiences that much of the time during the first

transit I sat with my eyes closed and with my face resting in my hands to get such relief as the attitude might afford. A great deal of the time I was very much depressed in spirit, but this fact I did not voice to any one, nor did I allow my conduct at any time to betray my feelings; but, on the contrary, I tried all the while to manifest a cheerful spirit.

It has been said that if a person were subjected for a sufficient length of time to absolute solitude, he would become insane, and I feel sure that there would be at least a strong tendency for the mind, subjected to such conditions, to become unbalanced. And for one not to be in close and intimate relations for any considerable length of time with both animate and inanimate nature as they appear on earth, produces about the same immediate influences on the mind and leads directly to the same final results.

Our great distance from the earth had completely severed us from all existence. Besides, our surroundings were constantly the same except that the comets, the planets, and the satellites were slowly shifting their relative positions. And although there was intermingled with our environments much of sublime beauty to stimulate to the highest degree the imagination and to induce wholesome solemn thought, our great distance from home and the monotony throughout the voyage added much to the loneliness of the situation.

Some people look with grudging or invidious eyes upon me because the opportunity to go on this wonderful expedition came my way. Well, it was, in a sense, a delightful trip; but the time during which we were making the first transit was the bluest days I ever ex-



FIG. 23. RING NEBULA IN LYRA.

(Yerkes Observatory.)



FIG. 25. PICTURE MAP OF THE MOON.

"Whoop-ee! Dis look at dat moon dis mawnin!" exclaimed Dick in his usual gay humor and with intense surprise. "White folks, she sho had de small-pox; her face is dis as speckled all over wid 'em spots as a pea-cock's tail is wid eyes."

(Nasmyth's "Moon.")



FIG. 27. MOON FIVE DAYS OLD.

This picture shows the Moon as it appeared to the inhabitants of the earth the day of our departure for the moon, and also at the time we reached destination.

(Yerkes Observatory.)

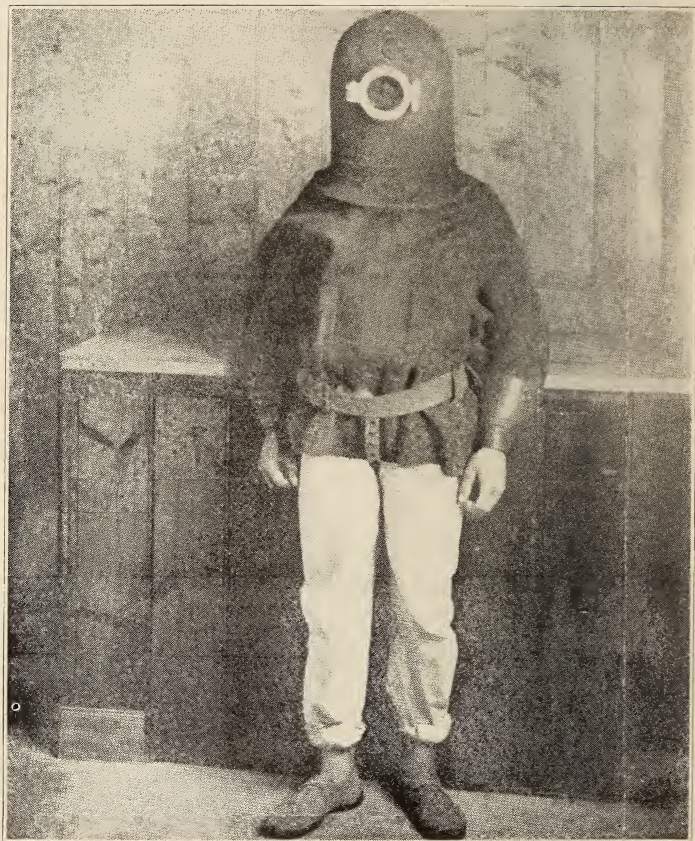


FIG. 28. PROF. GALVIN EQUIPPED FOR A TRAMP
AND A CLIMB AMONG THE MOUNTAINS.

(The Pictorial News Co.)

perienced. To describe my feelings at any time during this period is beyond the reach of words.

After surmounting the atmosphere of the earth, we were no longer in a temperate clime, nor were we gently floating through a golden depth of light. The degree of cold on the outside was intense, and there was no diffused light nor any such appearance as that which we ordinarily call daylight.

When I looked at the sun, I saw it as a blinding ball of fire, but the sky everywhere was black and the stars visible in every direction, just as if it were night.

The planets on which the sun's rays fell reflected their physical features in a way that was astonishing, yet but little light seemed to intervene between them and us; and a thick gloom seemed to gather about the ship, that reminded me, somewhat, of "Indian Summer" under a moon-lit sky.

This appearance was due to the absence of air, for it is this that diffuses or spreads the sun's light around us, when we are on earth, and hides the stars in daytime by producing an atmospheric illumination. This illumination has a blue color, when we look skyward, because it is the short, blue waves of light that are most scattered by the atmosphere.

Throughout the transit I longed to trace once more the boundaries of my earthly possessions, to survey with my eyes again a beautiful landscape with its valleys, streams and reliefs, and with all its natural flora and domesticated fauna, overspread by a sky of azure blue. I eagerly desired also to hear once more the sylvan notes of an endless variety of wild-birds coming from all the groves, to hearken to the trumpeting of

the night-storm, and to listen to the busy hum of industry; but these were not mine to enjoy.

At this time we were almost seventy thousand miles from home, and therefore every thing that lends beauty and tenderness to an earthly landscape was gone; I was unable to determine in what direction we were going, or whether we were moving at all; Capt. Ewald and Prof. Galvan were very irritable men and often disputed fiercely with each other and with other promoters of this enterprise; the thermometers on the outside registered the temperature at almost 300° centigrade, below the freezing point of water; the ship was popping under a tremendous strain due to the extreme degree of cold on the outside, and seemed to be in a rack all over.

All these things together with the perplexing experiences, the gloaming darkness that hovered around, and the dreadful silence that constantly prevailed made me feel that life was almost unbearable.

I felt a decided tendency to become reckless, or even desperate, and entertained grave fears that if the opportunity were to present itself, I might be tempted to leap wildly to my death into the boundless void.

But these unpleasant experiences were not without good fruits. Throughout the voyage, and especially during the time of the first transit, I lived a life that had in it more than its usual intensity, as did also the rest of the party; and each mind by its own quickened thought contributed to the energy of the general thought, and then the general thought reverted in a way to give volume and vitality to the thought of each individual.

I now feel that life is better worth the living than if I had not made the voyage. Such experiences reach us at points in our souls where we have not hitherto been alive, add tension to our conception of life, and discover ourselves to ourselves, and in this way practically increase our own aggregate. The frightful, the awful, and even the horrible may prove as inspiring as the beautiful; and one may, imaginatively at least, discover in a densely black night that which is invisible in sunshine.

CHAPTER XIII

LOOKING FARTHER TOWARDS INFINITY

Late on the evening of Dec. 1, we were eighty thousand miles from the earth, or one-third the way to our destination. Tangents drawn from the point in space designated by the position of our ship to points in the earth's circumference diverged 5° . In other words the earth presented a disk one hundred times greater than that of the full moon as seen from the earth.

About twelve o'clock, noon, on Dec. 7, we completed half the journey. At this time the measure of the earth by means of tangents was 4° . This is equivalent to saying that forty-five such disks as she presented, placed edge to edge, would span the arch of the sky. The earth now appeared as a great golden-colored disk ten feet in diameter and bounded around by a pale-blue border four inches broad.

The moon was almost on the opposite side of the earth from us, was approximately one hundred and twenty thousand miles farther from us than when we began the journey, and was approaching her last quarter. She appeared about the size of a large orange as she stood out in high relief and in sharp detail against

a sky of inky blackness, and the dark areas on her surface were hardly visible to the unaided eye.

In the meantime we had directed our gaze farther towards infinity.

Prof. Galvan pointed out Neptune and informed us that it was the most distant planet of which we have any knowledge. From the earth it is not visible to the naked eye; but when seen through a large telescope, it appears as a star of the eighth magnitude.

"How large," inquired Mr. Vanderlip, "is the planet Neptune?"

"Neptune has a diameter of thirty-five thousand miles," responded Prof. Galvan, "and a volume one hundred times as great as that of the earth."

"You will never be able to convince me that Neptune is a thing of such magnitudes," interrupted Mr. Shipley, "for when viewed through the large telescope, it appears to be no larger than a kernel of corn."

"The magnitudes attributed to this planet are within the bounds of reason," answered Prof. Galvan, "when its immense distance from us is properly considered in the reckoning."

"How great is the distance," asked Mr. Waite, "to the planet Neptune?"

"I will give you the necessary data," said Prof. Galvan, "and you may make the estimate for yourself. A train running at the speed of sixty miles an hour, day and night, without stopping," he continued, "would require five thousand and fifty-five years to complete the journey to this remote orb."

Everybody then got busy with pencils and paper, and within thirty minutes the estimate was completed,

and the true distance announced at two billion and eight hundred million miles.

At first these figures appear almost incredible; yet the path of the great comet of 1811 extends forty billions of miles beyond this far-away sentinel at the outpost of the planetary system, a distance so great that in spite of the comet's immense speed along its path, it has been authoritatively scheduled to return in not less than thirty centuries. And when this comet has reached its aphelion distance which is fourteen times as great as that of the planet Neptune, the same heavens will bend above it, that bend above us here on earth.

In other words, beyond the remotest point in this mighty orbit there is a vast chasm which is so immense that figures applied to it are meaningless; yet, beyond these depths so profound that to us they are limitless, the sky is ablaze with jewels—the stars glittering with the green of the emerald, the blue of the amethyst, and the red of the garnet.

In case two or more stars happen to lie very nearly in the same straight line from the observer's viewpoint, though at immense distances from each other, their light blends and they appear to the naked eye as a single star. Many stars of this kind have been found to be in some way physically connected and form binary, triple, and even septuple systems according to the number of stars composing the separate groups.

We saw many groups of stars of this class during the voyage. And the individual members composing each system revolve in elliptical paths about their common center of gravity and often have different colors presented in all their richness and beauty, some of

which are combinations of colors complementary to each other. Here, is a blood-red star with a green companion; there, an orange and a blue sun; and yonder, a yellow and a purple one. And truly I saw in the stars every color seen in the rainbow of the sky and every tint that blooms in the flowers on earth.

Another interesting class of objects was that of the star clusters of which there are thousands.

One particular group which I saw in the Toucan is compact in the center, where it is of an orange-red color, while the exterior is composed of purely white stars, making a border of beautiful contrast.

While my gaze was fixed upon this beautiful archipelago of worlds, I felt as if I were gazing into a great casket of precious gems.

Beyond the star clusters are numerous, faint, misty objects which resemble specks of luminous clouds. These are called nebulae and differ from the star clusters in not being resolvable into separate stars when viewed through the telescope.

From our view point at this time many of the nebulae were visible to the unaided eye; and the telescope revealed thousands, many of which are not, perhaps, known to astronomical science.

Among the most conspicuous and beautiful of this class of objects are the following: the Great Nebula in Andromeda, the Spiral Nebula in Canes Venatica, the Magellanic Clouds, the Crab Nebula in Taurus, the Trifid Nebula in Sagitarius, the Net-Work Nebula in Cygnus, the Green Nebula in Orion, the Ring Nebula in Lyra, and the Dumb-bell Nebula in Vulpecula.

The distances to the nebulae surpass our comprehension. Prof. Monahan informed us that a ray of light,

which travels at the rate of almost two hundred thousand miles a second, would require, according to some astronomers, eight hundred thousand years to span the gulf that intervenes. Although we were thousands of miles away from the earth, these startling figures made me feel that we had not yet left home. I was not able to comprehend even the smallest part of such a magnitude, yet the statement, which hinted at it, taught me something, at least, of the limitless expanse of that space in which God is working the mysterious problems of creation.

At the nebulae I gazed long and wonderingly. I could conceive of nothing in all the visible universe that was more suggestive of the magnificence and the immensity of creation than they. If a telescope of sufficient magnifying power were directed at any one of the nebulae, if would, no doubt, reveal the fact that each little patch of smoke is a host of suns as large or even larger than our own, which would appear as so many electric sparks fixed in the concave of the sky, scintillating with different colors like diamonds and quivering like things of life.

The planets, the satellites, the meteors and the comets all about us, which we were able to count by thousands, were constantly shifting their positions; but over all shone the eternal stars, each with its place so accurately marked that to the astronomers among our number no deception was possible. The stars have been called the "landmarks of the universe." They seem to be placed in the heavens by the Creator, not alone to elevate our thoughts and to expand our conception of the infinite and the eternal, but to afford us among the constant fluctuations of our own earth something unchangeable and abiding.

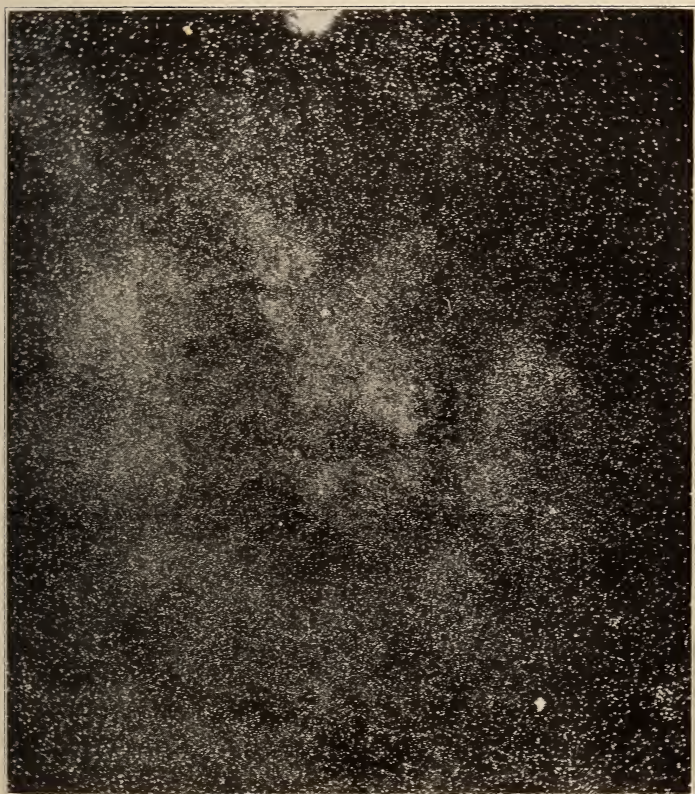


FIG. 29. STAR CLOUD IN SAGITARIUS.

Beyond the aphelion distance of the remotest cometary orbit belonging to the solar system is a vast chasm which is so immense that figures applied to it are meaningless; yet, beyond these depths so profound that to us they are limitless, the sky is ablaze with jewels.

(Yerkes Observatory.)

In short, the solar system taken together with the stars, the star-clusters, and the nebulae presented before us a scene that was to me at once and constantly the symbol and fact of majesty. In the presence of all this weird and wondrous beauty the tenderest sentiments are aroused in the soul. A feeling of awe and reverence, and of softened melancholy mingled with the thought of God, comes over one and awakens within him his better nature.

But the appalling sense of trackless space, which the immeasurable stretches of multiplied trillions of miles to those distant suns inspires in the soul, at times completely overwhelmed me with suggestions of the Infinite One until no human language seemed appropriate or competent to give expression unless it shaped itself in prayer.

Truly I felt like I had come into communion with another life. Those far-off lights seemed to me to be full of meaning and looked inquiringly down upon us; and although I could not quite read and grasp their messages, I did realize that the whole foreshadowed for man a great and glorious future; and my soul bowed in humble submission and reverence to the Creator and Governor of all things, and more strongly than ever before asserted its immortality.

CHAPTER XIV

THE LIMIT OF THE VOYAGE REACHED

On the morning of Dec. 16, the undivided and ardent interest that most of us had, up to this time, been taking in the stellar world in general began to wane rapidly and to give place to a new field of thought.

The moon was surely coming our way and rapidly completing her revolution around the earth for that lunar month. At thirty-five minutes past eight o'clock p. m. of this same day the moon was due to be at her new, and we were scheduled to reach destination on Dec. 21, five days after new moon.

Every one had begun to realize that the time was right at hand when he would experience what it is to be a lunarian. I do not know how others felt about the attempt at landing, but as for myself, I experienced a deep, and strange sense of fear. I felt sure that such a feat would necessarily be attended by great hazard.

During most of the last five days next preceding our arrival at destination I sat gazing anxiously and hopefully at the moon as she came in her heavy swing around the curve of her orbit.

Time went on; and at seven o'clock a. m. on Dec. 18, we found ourselves, in spite of eternal vigilance, in

another shower of meteoric bodies, and our lives again in great peril. About nine o'clock p. m. on Dec. 20, the last of the more prominent of this shoal went by, to the exceeding great joy of those who were able to realize the hazardous position in which these flying missiles placed us. Prof. Monahan said this last swarm consisted of the laggards of the first and only shoal of little worlds we had been in.

At two o'clock p. m. on Dec. 19, the moon appeared to be the same size as the earth, was about sixty-five thousand miles away, and coming almost directly toward us. From this time on she rapidly became the most conspicuous object in the heavens and took on the uneven and rugged appearance of a world like our own, as she came sweeping along through space at a speed of more than two thousand miles an hour.

Although we were approaching the moon from her darkened hemisphere, I was able even at this great distance to perceive by means of a thread of light about her border her entire outline and to discern the cavities and the elevations of almost every size and order upon her surface which presented a cold, blue, and flinty appearance—a rather uninviting abode for man, I thought. And truly I was surprised to discover that I could discern objects on the moon's surface as readily by means of refracted light as by direct light.

Almost before I was aware the twenty-first of December came, the day on which we had expected and arranged to reach destination.

"We have reached the point of equilibrium," said the captain at four o'clock, "and we must land today or never."

In spite of the fact that these words were, in a sense, consoling, this utterance caused the loss of self-possession in the cases of many and thereby threw them into a state of confusion. As a result they walked nervously about the room, thronged about the observation windows, and closely watched every movement of the three men who held our destiny in their hands.

At seven o'clock a. m. the moon was only fifteen thousand miles away, was rapidly approaching us, and was due to pass the point where our line of travel intersected the moon's path, about half past one o'clock in the afternoon.

Capt. Ewald and Profs. Monahan, Galvan and Rider had been almost constantly at the steering wheel since four o'clock that morning, appeared to be somewhat confused, and in undertones but in a spirited manner seemed to be discussing something of a serious nature.

During these earlier hours of the morning the craft had been violently tilting and running in a jerky manner. Throughout all this time I asked no question, entertained grave fears that something had gone seriously wrong with the running gear of the ship, and silently sat in dreadful suspense.

The reader will, no doubt, readily call to mind the fact stated at the outset, that one of the well-deserved merits of Capt. Ewald's invention, the running gear of the ship, is its power, when the parts are properly adjusted, to neutralize or to destroy the force of attraction so that no heavenly body can possibly exert any influence upon the ship.

And, about eight o'clock I was informed that the captain, in order to liberate the universal power of attraction, had deranged the machinery by a displace-

ment of its parts, which had throughout the transit warded off attractive influences, gauged the ship to a uniform speed and held it to a fixed course.

The prime object in freeing this great universal force in nature just at this particular time was to render the conditions possible and favorable for the moon to exert her utmost attractive influence upon the ship and thereby to give it greatly-increased speed in the direction of destination.

It was clearly manifest to all that it would be necessary for the ship to acquire even a greater speed than that of the moon in her orbit, otherwise it would be utterly impossible to effect a landing.

As a result of this wise plan suggested and urged by Profs. Monahan and Galvan, and of Capt. Ewald and Prof. Rider's skillful operation of the machinery, the ship fell at a terrific speed in the direction of the moon, with more or less check on it; and this is the explanation of the ship's unsteady movements during the earlier hours of the morning.

Partly by the positive assurance of the best authorities on board the ship that we might reasonably expect a safe approach to the limit of our journey, and in part by the attractive appearance of the moon's physical features just at this particular time, I unconsciously dismissed from my mind the main burden of my dark forebodings and throughout the remainder of the voyage gave undisturbed attention and study to the wonderful relief map of the moon's disk as she loomed up in pretty sharp detail by refracted light.

Up to this time my associations with those scholarly and daring scientists had been most pleasant, and within a certain sphere, highly profitable; and the sub-

lime and magnificent views of the heavens that had constantly been before us had already given me a memorable realization of the insignificance of man and his works, and in short, of all earthly things, except so far as they are related to nature and to God.

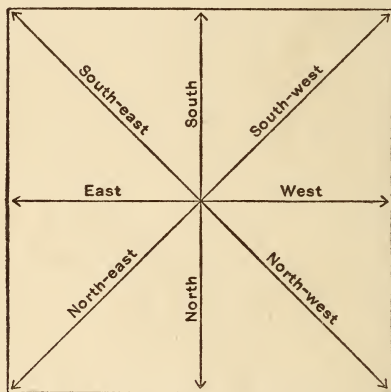


FIG. 24. DIRECTIONS ON THE PLATES.

The directions on the plates shown in this work are exactly the opposite of those found on the maps in our geographies. See the accompanying diagram.

Everybody now became joyous and conversation opened up lively, a thing very unusual heretofore.

Some wondered and questioned if the moon were inhabited by intelligent beings, and if so, what kind of looking creatures the Selenites were. Others wondered and questioned if those imaginary beings were a sin-stricken people like the inhabitants of earth, and if so, whether there were among their number soldiers of the cross enlisting to bear to those benighted souls of their fellow beings the tidings of salvation.

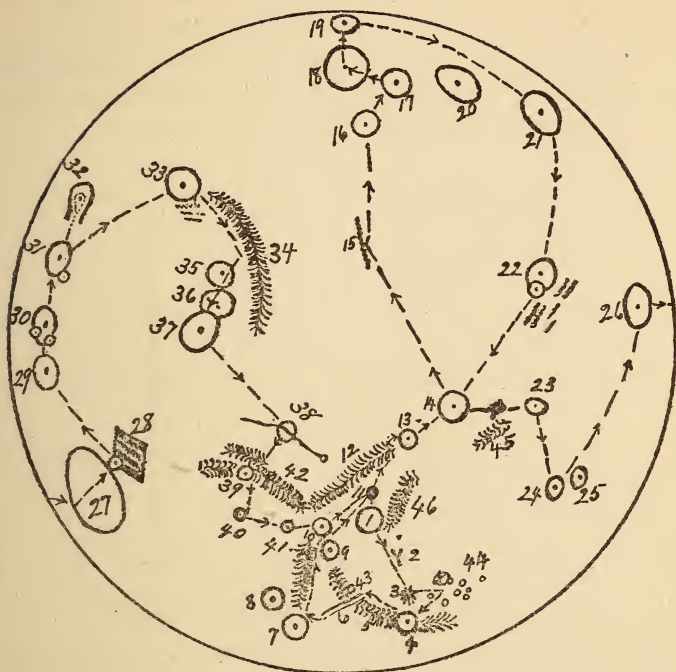


FIG. 26. KEY MAP OF POINTS WE VISITED.

- | | |
|--|---|
| 1. Archemides. | 11. The Point of Arrival on, and Departure from the Moon. |
| 2. The Unnamed, Y-shaped Mountain Group. | 12. The Apennine Mountains. |
| 3. Pico. | 13. Eratosthenes. |
| 4. Plato. | 14. Copernicus. |
| 5. The Alps Mountains. | 15. Murus Rectus or the "Straight Wall." |
| 6. The Alpine Valley. | 16. Tycho. |
| 7. Aristoteles. | 17. Longomontanus. |
| 8. Eudoxus. | 18. Clavius, or Playfair. |
| 9. Aristillus. | 19. Newton. |
| 10. Autrolycus. | |

- | | |
|---|---------------------------|
| 20. Schiller. | 32. Fernurius. |
| 21. Schickard. | 33. Piccolomini. |
| 22. Gassendi. | 34. The Altia Mountains. |
| 23. Kepler. | 35. Catherina. |
| 24. Aristarchus. | 36. Cyrillus. |
| 25. Heroditus. | 37. Theophilus. |
| 26. Grimaldi. | 38. Hyginus. |
| 27. Mare Crisium or the Sea
of Crises. | 39. Menelaus. |
| 28. Palus Somnii and Proclus. | 40. Bessel. |
| 29. Langrenus. | 41. Linne. |
| 30. Vendelinus. | 42. The Heamus Mountains. |
| 31. Petavia. | 43. Mont Blanc. |
| | 44. The Teneriff Peaks. |

In fact there was among our number all manner of speculation concerning the things we would see and experience when we reached destination.

Dick Prouty, the colored man, was certainly the most joyous soul I ever saw. He did not seem to realize what, in the nature of perils, we were yet liable to encounter even though we should effect the landing successfully. He was in ecstasies over the thought of having once more a solid foundation on which to place his feet, and was constantly making pert and apt remarks and breaking into loud and hearty laughter.

I was able at this time to discover readily and easily that a very large part of the moon's visible hemisphere is almost solidly pitted over with crater-like hollows of all sizes.

At eleven o'clock Capt. Ewald instructed Dick Prouty not to prepare the noon meal until after the landing had been made. Prof. Galvan then called the colored man to the observation window to take a view of the



FIG. 30

(Nasmyth's "Moon.")

FIG. 30. THE APENNINE MOUNTAINS, ARCHEMIDES,
AND SURROUNDINGS.

The great, high-land system in the upper part of the picture is the Apennines. The large crater in the upper, right-hand corner is Eratosthenes. The three large crater rings just beneath the center, in the order of their sizes, from the largest to the smallest, are Archemides, Aristillus, and Autorolycus. The smaller system of high-lands near the center of the picture and adjacent to the wall of Archemides is the Wolf Mountains.

Note the huge clefts extending about over the surface, in various directions.

The small, jet-black, circle lying midway between Archemides and the Apennines marks the spot of our arrival on, and departure from, the Moon.

Locate this region in Figs. 25 and 32. Also see Figs. 34, 35, and 39.

moon at short range, at which he gazed steadily for some time.

"What do you think of it, Dick?" inquired Prof. Galvan.

"Whoop-ee! Dis look at dat moon dis mawnin!" exclaimed Dick in his usual gay humor and with intense surprise. "White folks, she sho had de small-pox; her face is dis as speckled all over wid 'em spots as a peacock's tail is wid eyes."

At twelve o'clock the moon was less than five thousand miles away, was moving almost directly toward us at the speed of nearly forty miles a minute, and presented a magnificent view of her massive mountain systems, her extensive lava seas, and her great walled plains; and in spite of the fact that she was charging upon us through the heavens at a speed and with a force indicating that behind her was all the power in the universe, her approach was as silent as the grave.

Besides the moon's more prominent physical features referred to in the foregoing paragraph there were now plainly to be seen thousands of smaller cavities and elevations of all shapes and degrees of irregularity.

More than anything else to which I can compare them, they resemble great rain pits in deep, dry dust, or the momentary cavities that are formed on the surface of thick, boiling soap when bubbles burst.

At half past one o'clock p. m. the center of the moon was at the point at which the straight path of the ship intersected her orbit, and the craft was about one thousand miles from her surface.

At two o'clock the moon had moved from this point along her orbit one thousand and two hundred miles, or a little more than half her diameter, and had gone by us.

I felt sure we had lost our opportunity of catching this little world in her wild flight, and thereby had been deprived of ever knowing anything more about her strange and rugged beauty of which we had gotten only a glimpse.

But it exists as a fact in nature that an object like our ship, set free to be acted upon by a powerful attracting body like the earth or the moon, will acquire within a few minutes a much greater speed in its descent than that of the planet itself in its orbit, which at the time is exerting the influence.

Accordingly at the opportune time Capt. Ewald and the astronomers, by the displacement of the parts of the ship's running gear, liberated or set free for the last time the universal attractive forces in nature in order that the moon might exert her utmost influence upon the ship and thereby give it great and steadily-increasing velocity in the direction of destination.

And while the ship's speed continued to increase rapidly according to the law of falling bodies, the captain slued the craft on a comparatively short curve and at the same moment applied all the power possible from within to give it the course and the speed of the moon in her orbit. This he easily did by a skillful adjustment and management of the ship's running gear. This great feat sent our craft racing side by side with the moon at a distance of two hundred and fifty miles from her surface, a relative position which enabled us to descend to the surface at leisure; for to all appearances, and practically, too, the moon was then stationary with respect to the ship.

This extraordinary act of skill on the part of Capt. Ewald and Profs. Monahan and Galvan was the exploit that most of us feared would end in disaster.

Finally at half past two o'clock p. m. on this same day, Dec. 21, 1914, after a most wonderful but perilous voyage of twenty-nine days, four hours, and thirty minutes, our craft, noticeably scarred in a number of places by small, flying missiles, gently descended to the surface at a point near the center of a broad, and comparatively level valley between the foothills of two picturesque mountain systems, the Apennines on the east side of us, and the Wolf Mountains on the west. (See Figs. 32, 34, and 35.)

Just as the ship settled down Dick Prouty grinned, gave his head a slight, quick jerk, and broke the silence in the following utterance.

"A bi-plane is a tame thing compared wid dis trick sho's you born."

Everybody else stood breathless and looked strangely and pleasingly at one another, but for some little time no one spoke a word.

CHAPTER XV

OUR THANKSGIVING AND OUR BATTLE WITH THE ELEMENTS

When we realized that our ship was actually in contact with the surface of the moon, every heart swelled with emotion; and even as Noah's first act after coming out of the ark was to sacrifice to the Lord, and as Columbus, when he first set foot on the land of the New World, knelt, kissed the earth, and offered thanks to the Creator, so we were all ready, even before the door of our craft was opened, to join heartily with the Rev. Bryan Merritt in prayer as he poured out his soul to Almighty God in the following words:

"O thou great God of the Universe, at whose command all these splendid worlds came into existence, whose providence holds them in their courses and marks their destinies, how our hearts overflow with gratitude and thanksgiving to thee, that amidst all this immensity thy loving care can extend, and has extended, even to such insignificant creatures as we. Thou hast preserved our lives through the dangers of a voyage never before undertaken by mortal men, and brought us safe to luna firma.

"Now, our gracious Preserver, we know not what perils may yet lie in our pathway, so we commit our-

selves into thy merciful keeping, and trust thee still to guide and to lead us safely on our Journey over the moon's surface, and back again to our loved ones in the far-away world from which we came.

"Nay, more, we trust our lives into thy keeping, and when the final great voyage from Time to Eternity shall be made; we shall not fear. In the name of our loving Saviour receive our thanksgiving and hear our petitions—Amen."

Until five o'clock of this afternoon the massive steel door of the craft remained closed, locked, and sealed.

During this time Capt. Ewald, Dr. Wharton, and Profs. Monahan, Galvan, and Rider were aside to themselves engaged in a private consultation, while the rest of us stood at the observation windows gazing out upon the arid, rocky plain about us and at the jagged cliffs of the foothills in the distance. The outside looked like a deathtrap.

At the private meeting of the promoters of this enterprise Dr. Wharton advised and commanded that no one be allowed to pass out into the open until a thorough investigation had been made to determine whether the conditions on the outside were favorable to such a venture.

A careful and thorough test revealed the fact that there is an atmosphere surrounding the moon and that it is very highly rarefied and stands at a great altitude.

On forcing a sufficient quantity of the air into one of the chambers in the dome of the ship to indicate a barometric pressure equal to that of the earth's atmosphere at the level of the sea and applying a chemical test it was found to contain exactly the same elements in about the same proportion as the atmosphere of the earth, a thing very encouraging to us.

Finally after due deliberation and experimentation Dr. Wharton and others advised that those of us who felt inclined to want to experiment with the environments might pass to the outside.

Five of us volunteered to make this venture and were at once ushered into the antechamber. Prof. Purnell quickly pumped most of the air from this vestibule in order to relieve the door from part of the tremendous atmospheric pressure from within, and then by means of strong and heavy machinery turned the lock and broke the seal.

Dr. Wharton then ordered us to pass out and charged us particularly not to go many steps from the door until permitted so to do. This earnest injunction was a precaution against oxygen starvation and freezing to death, and it was a wise and timely command we learned by experience.

Then for the first time since the hour of our departure for the moon on November 22, and to the extreme joy of all, the door of the craft swung ajar and we slowly and cautiously filed out into a strange and foreign world.

I first glanced my eyes at the heavens above us and then looked rapidly about us on every side in wonder and astonishment. It was the most desolate, and at the same time the most strangely beautiful world that God in his wisdom has ever seen proper to create—more charming in her rugged relief than it is possible for even the most imaginative mind to conceive of.

By the time I had gotten a fairly good glimpse of the wonderful landscape about us in its picturesque beauty made plainly visible in the vicinity of the ship by the light of the sun reflected by the earth, my hands, face, and neck felt as if they were being gently but rapidly

pricked by millions of fine cambric needles with delicate points, and my pulse had increased to more than one hundred and twenty beats to the minute. In another moment I was rapidly becoming dizzy and growing sick.

This was the experience of everyone who ventured out. And discovering we were not just at this time equipped for withstanding the intense cold registered at more than 250 degrees Centigrade, below the freezing point of water and an atmosphere many times more highly attenuated than that to which we had been accustomed on earth, we retreated in haste to the refuge of the ship.

Although the thermometer registered the temperature at a degree somewhat above that which uniformly prevailed throughout the transit, our suffering from the extreme cold alone during the short time we were exposed to the elements was almost beyond endurance. I shivered with cold so frightful that no winter experience I had ever before had could give any idea of its intensity, nor can the extreme cold that polar explorers have ever experienced be likened unto that of this lunar night.

Within a very short time after returning to the ship we fully recovered from the ill effects of our exposure to the surroundings and the new conditions of things in general on the outside.

It was not an intense surprise to the promoters of this enterprise to find such a degree of cold and an atmosphere of such great tenuity on our satellite. This state of things they rather expected and made adequate preparations to meet successfully, if necessary. The inferior size and density of the moon and the long lunar

nights would very naturally lead speculative scientists to such a conclusion.

The main fortification against the intense cold and the drawn-out state of the air with which we were forced to battle was the copper helmet referred to briefly in the fourth chapter, which we wore only when away from the ship on exploring expeditions and which served as a safe-guard against freezing to death and oxygen starvation.

This helmet is rather large and clumsy and resembles, somewhat, the kind of hat usually worn by city policemen while on duty.

It comes down loosely over the head and the neck and attaches to a heavy, loose, closely-woven jacket which is worn over the arctic suit and which covers the entire trunk of the body.

The inside of the helmet communicates freely with a net-work of small, flexible, metal pipes just inside the lining of the jacket.

There is installed on this helmet a miniature air compressor exactly after the type of the condenser installed on the ship, by means of which it can be filled quickly and easily with compressed air by the wearer at will.

There is installed also on this helmet an Edison storage battery of the submarine-boat type. By means of this little battery heat is produced to temper the pent-up air for breathing purposes, and light is generated which shines out through a large bull's-eye located immediately above the observation window in front, and thus forms a strong searchlight when exploring canyons, gorges, and unfathomable clefts or rents in the moon's surface.

This battery in miniature also rapidly revolves a small electric fan located in the top of the helmet,



FIG. 31

(Yerkes Observatory.)

FIG. 31. THE MOON SEVEN DAYS OLD.

This picture represents the moon as it appeared to observers on earth the day we witnessed the lunar sun-rise.

Within the illuminated hemisphere is a large figure roughly resembling the outline of a man standing on his head. This is not, however, the "Man in the Moon." Turn the picture one-fourth around to the left, and then the man will appear to be lying with his face down-ward. Note that his right leg is larger than his left one, and that his nose is prominent and his mouth large and protruding.

The Sea of Serenity forms the man's head, the Sea of Tranquility his body, the Sea of Fecundity his right leg and the Sea of Nectar his left leg. And the large, dark detached area obscurely circular lying just in front of the man's stomach is the Sea of Crises.

The Palus Putredinus, an embayment of the Sea of Serenity, separates the highlands in the lower part of the picture into two mountain systems, the Apennines extending upward to the right, and the Caucasus extending down-ward to the left. The two vulcanoids or craters to the right of the strait and on the "terminator," or border of the advancing sunlight are Aristillus and Autrolycus. (See Figs. 30, 32, 34, and 35). The two vulcanoids in the lower part of the picture, under high illumination, are Aristoteles and Eudoxus. (See Fig. 38).

which keeps the body warm by sending currents of warm air around it by means of the system of flexible metal pipes located within the lining of the jacket.

At the same time the potash solution with which the battery is charged absorbs the carbon-dioxide given off from the system at each exhalation, and an appliance generates oxygen, and thus completes a system of air purification and rejuvenation.

Thus equipped we were able to go against any and all odds where and when we pleased and stay as long as we wished with comparatively little suffering except that arising from fatigue due to over-physical exertion.

CHAPTER XVI

OUR SECOND VENTURE OUT

Our real contact with the moon's surface and our battle with the elements quickly aroused in everyone the true spirit of adventure, and, as a result, it was with a considerable degree of impatience that we waited for the opportune time to experiment again with our environments.

Just before the second venture out Prof. Monahan delivered a thirty-minutes lecture on astronomy. Among his utterances on this particular occasion were the following:

"Owing to the fact that the moon's axis is almost perpendicular to the plain of her orbit, we shall experience no change of seasons during our month's sojourn on our satellite. And owing to the additional fact that the moon rotates exactly once upon her axis during the time of her synodic revolution, the earth will remain permanently fixed in the sky, the sun will rise and set once, only, in a single lunar month, and the stars will defile along the sky from east to west about 13° every twenty-four hours; provided we do not, in the meantime, shift our position on the surface.

"The sun is now about 26° below the eastern horizon, is coming up at the rate of 13° each terrestrial day, and

therefore will appear in about forty-eight hours from the time we reached our destination. This event, the sun-rise, will end a lunar night equal in length to fourteen of our terrestrial days. And this long night of more than arctic cold will be succeeded by a day of equal length, during which the sun will pour down his rays unmittigated by an atmosphere sufficiently dense to temper them; and, as a result, the temperature of the rocks will probably rise above that of boiling water by the time he reaches his lunar zenith.

“The volume of the moon is only one-fiftieth, and her specific gravity only seven-elevenths, that of the earth; therefore, her mass or weight is a little more than one-eightieth that of our planet. As a result of the moon’s inferior mass, the weight of any object at her surface is only one-sixth of what it would be at the surface of the earth. The moon’s feeble power of attraction is in part, if not wholly, the cause of the highly-attenuated state of the air enveloping her, and of the great altitude at which it stands.

Under the exciting influences all about us it had not until this very moment appeared to any one that we ourselves had decreased in weight. Immediately following the close of the lecture we in turn rapidly mounted the scales to test the matter out.

I found my **own** weight at this time to be twenty-four pounds. The day of our departure for the moon my weight was one hundred and forty-four pounds, and I was sure that I had not, during our trans-ethereal flight, lost any of my avoirdupois. On applying the test it was found that every one had fallen away in weight in about the same proportion.

Finding the moon to be surrounded by an atmosphere extremely scant and highly rarefied was at first a great disappointment to Profs. Thorsen and Knowlton, the aviators. They had expected to have the greatest time of their lives at making air flights in our neighboring little world, but now their prospects for such a delightful experience seemed to be defeated. But their hopes quickly revived when Profs. Monahan and Galvan assured them, and all of us, that whatever degree of hinderance might be brought about by an atmosphere of great tenuity, due largely to the moon's feeble power of attraction, would be wholly offset by the greatly-reduced weight to be raised and borne along, due to the same cause.

At the close of the lecture Capt. Ewald commanded us to don our gloves, jackets, and copper helmets for a tramp and a climb among the foothills of the mountains. As soon as we were fully equipped, the door of the ship again swung ajar and all except Capt. Ewald, Dr. Wharton, and Prof. Purnell passed out.

On this our second venture our equipments were such as to enable us to withstand the intense cold and the drawn-out state of the atmosphere, and therefore to make the conditions highly favorable for giving undisturbed attention and study to our surroundings.

The sky sparkled with incomparable splendor. Not even the glories of a tropical night on earth can give any idea of what night on the moon is.

The heavens above us were as black as a storm cloud and studded with millions of stars which were shooting their arrows of light upon us from the remotest depths of space. (See Fig. 29).

Most of the visible hemisphere of the moon was still in darkness, it being at that time on the opposite side

from the sun, but was considerably illuminated by the full earth which appeared about the size of the rim of an old-time spinning wheel, showed pretty sharp delineations of her continents, and shone down upon us almost directly from the zenith with a steady, dull light.

An earth-lit night on the moon is fourteen times as bright as a moon-lit night on earth. In fact the earth reflects a sufficient amount of light to enable one to see objects, such as large apertures, ragged protuberances and extensive denticulations on the cliffs, and large boulders on the plains from one to two miles away.

In all directions as far as my eyes could reach the valley was well covered with light-brown stones of various sizes and shapes, and a scant, red dust, which appeared as though they had not in any way been disturbed since the creation. I could hardly resist calling this particular section of the moon's surface Helluland, a name signifying the "land of flat stones." And a long way off, beyond this barren, desolate, rockstrewn plain the summits of the hills and the mountains illuminated by the mellow light reflected by the earth resembled "white caps" glistening on the sea.

Except the great unevenness of the moon's surface and the total absence of sand dunes, the general view of this lunar landscape about us was much the same as that of a very bright moon-lit landscape in the Sahara Desert.

Everywhere about us the physical features were the same—great, lumpy elevations, deep ravines, steep declivities, wide-extended plains, and enormous clefts—and presented the appearance of a ruined world, a desolate waste.

The point at which our ship came to its position of rest was on the edge of a prodigious rent in the surface, more than two miles in width and sixty miles in length, and so deep in most places that it was not possible, even by the aid of the search lights in our helmets, to see the bottom of it.

Not a thing did I see about us to indicate in the slightest degree the presence of life in any form.

In short, the landscape view in whatever course I directed my gaze was in every respect the symbol of complete and perpetual desolation and destruction.

There was constantly in my ears a roaring sound as of high wind a great way off, but this sound was a delusion—a mere sensation due, most likely, to my ears' not being adapted to the drawn-out or rarefied state of the air pent up in my helmet.

Our environments in general, and more especially those that appealed to the eyes, induced a feeling of loneliness that language cannot express, and caused me sometimes to doubt that I was myself and often to wonder if I were not merely living in a wild dream.

We were out on this tramp five hours and twenty minutes, walked approximately twelve miles, and at one time were three and a half miles from the ship.

CHAPTER XVII

HOW WE EMPLOYED TIME UNTIL SUN-RISE

During the two terrestrial days after our arrival at destination, while we waited for the sun to rise, we employed most of our time in exploration and light amusements of various kinds in the vicinity of the ship.

Scientists tell us that eons ago huge beasts, such as the dinosaur, the megatherium, and the proboscidian roved through the dark jungles and ambled over the broad plains on earth; and, to back up their assertions by evidence, they show us their giant bones found in the rock formations of by-gone ages. So as we leisurely strolled about in the vicinity of the spot where our ship was moored, gazing in wonder at the huge, rough cliffs, into rents of mammoth proportions, and about over the rock-strewn valleys and plains, I wondered if back in the misty past huge and strangely grotesque creatures like those referred to above zig-zagged in clumsy flight over this desolate landscape, and thought what a wonderful place we were in for a geologist to speculate.

We climbed eminences, which finally proved to be the foothills of two great mountain systems, explored clefts

and caverns, and leisurely trailed along what appeared to me to be deserted river beds, searching for fossils and now and then picking up a curio, and pitching small stones into abyssmal rents or chasms.

Owing to the inferior size and density of our satellite gravity at her surface, as previously stated, is much weaker than it is at the surface of the earth. We were able to raise six hundred pounds as easily as we could one hundreds pounds at the earth's surface, and to toss about rocks and boulders as if they were pieces of wood or cork.

Our own weight also being reduced in the same proportion while our muscular strength remained the same, we were able to walk, to run, and to leap in a way that was astonishing. And being thus aided by this natural state of things and by our equipments briefly described in a foregoing chapter, we could withstand the intense cold and the great tenuity of the atmosphere, make long journeys on foot, and ascend lofty mountains, more easily and with much less fatigue than we can on earth.

In a sense we became as children and vigorously engaged in all manner of light amusements. Even Capt. Ewald, Dr. Wharton, and Prof. Monahan took part with the rest of us in foot-racing, jumping, and the game of leap-frog.

It was not a difficult feat for even the clumsiest of us to spring upward into the air from ten to fifteen feet, jump recklessly from elevated positions into pits and chasms from twenty to thirty feet in depth, and spring like panthers or kangaroos across gulches from twenty-



FIG. 32. MOON NINE DAYS OLD.

This plate represents the moon as it appeared to observers on earth at the time of our first biplane flight. It will be observed that several new features have appeared beyond the northern end of the Apennines. It will be observed also that the contrast of hue is less distinct than in Fig. 31.

(Lick Observatory.)

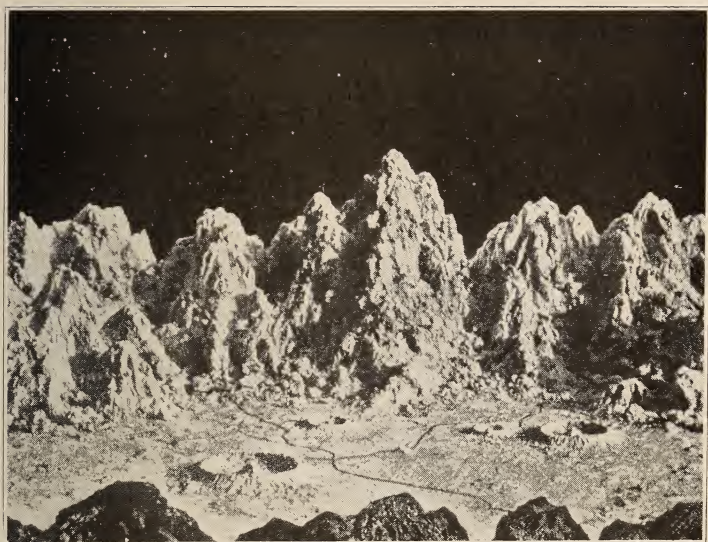


FIG. 33. THE LUNAR APENNINES. (IDEAL).

And they stood forth gaunt and naked, and like the hills, the valleys and the planes everywhere, were to all appearances at least, totally devoid of both vegetation and animal life.

(Nasmyth's "Moon.")



FIG. 34. AN ENLARGED VIEW OF THE APENNINE MOUNTAINS, ARCHEMIDES AND SURROUNDINGS.

This plate shows a part of the Apennine Mountains near the Palus Putredinus, an embayment of the Sea of Serenity, where it breaks through the mountain wall and connects with the Imbrium Sea.

(Yerkes Observatory.)

five to thirty feet broad, without experiencing anything of a disagreeable nature more than a slight sense of fatigue and shortness of breath.

Owing to the fact that it was not absolutely safe to compress into our helmets a quantity of air sufficient to produce a pressure equal to that of the earth's atmosphere to which our bodies up to this time had been accustomed, we suffered some from oxygen starvation; and, owing to the additional fact also that the outward pressure or the expansive force of the air pent up in the tissues and the cavities of our bodies was greater than that of the surrounding atmosphere, we suffered much from physical injuries due to the same.

My flesh became so bloated or swollen that at times I could scarcely bend my limbs without producing pain; my eyes burnt and my vision became slightly dim; my ears became bunged and often ached intensely; most of the time my appetite was dull; sometimes blood oozed from the pores of my skin in the manner of sweat, but not profusely, and my nose frequently bled; my hair became dead, dry, and rough and stood out perpendicular to my cranium; and on one or two occasions I felt as if I were smothering to death.

Near the close of the second day of our sojourn on the moon all the members of our party were more or less in this same physical condition and experienced similar unpleasant sensations.

About eleven o'clock a. m. on the morning of December 23, just as a number of us returned from a tramp among the near-by hills, Dr. Wharton came from the little chicken coop carrying the remaining four pigeons and said:

"Boys, here are the rest of your birds; turn them loose and let them go."

We at once took charge of them, carried them to the outside, and offered them their freedom. They "shook out" their feathers, snapped their eyes vigorously and wildly, and gasped for breath. At first they refused to fly and clung tightly to our fingers. Finally they dashed off as if frightened, each pursuing a different course, and zigzagged wildly in their flight. It was with extreme difficulty that they kept themselves above the surface; and, no sooner would they perch, than they would dash off again at full speed.

Within a minute's time they had all disappeared behind the projecting spurs of the cliffs, and I did not see them again. On account of the intense cold and the scant atmosphere, I think it perfectly safe to presume that they all perished within a few minutes after they gained their freedom.

Exactly at twelve o'clock, noon, Dick Prouty announced that dinner was ready. Just as we sat down to lunch Prof. Monahan spoke as follows:

"Gentlemen, early in the afternoon we shall have the opportunity of beholding a most wonderful spectacle—a lunar sunrise. Do not get separated from one another before this event occurs. Prof. Galvan and I have made extensive preparations for making observations at the time of this occurrence, and it may become necessary for us to go on board the ship and move to some highland system in order to find a more advantageous position from which to view this unusual phenomenon."

Immediately after the close of the meal Capt. Ewald, Dr. Wharton, and Prof. Monahan and Galvan took a position to themselves and entered into a private consultation, while the rest of us in bright anticipation of a glorious sunrise and sunlit landscapes sat wondering what the next orders would be.

CHAPTER XVIII

THE PHENOMENON OF A LUNAR SUN-RISE

Almost in strict accordance with the estimate made by the astronomers on the day of our arrival at destination the sun rose on the afternoon of December 23.

At one o'clock p. m. Prof. Monahan, who is a mathematician of great merit and an eminent astronomer, informed us that the sun was getting very near the horizon and would appear at forty minutes past two o'clock of that afternoon.

At the same time he advised that we go on board the ship and move out of the broad valley, one hundred miles westward, to greater altitudes in order to be in a more favorable position to witness this sight.

The advice was followed out; and in thirty minutes our ship was perched on the crest of one of the more lofty ranges of the Wolf Mountains, a position which gave us an excellent scope.

At half past two o'clock it was announced that the sun was right at the horizon and that within a few minutes the edge of his great disk would appear.

Every one had procured a small telescope and was keeping a sharp and steady lookout in an easterly course, or in the direction of the Apennine Mountains,

as if trying to see who could get the first glint of his rays. Truly we watched with a far greater degree of interest than if we had been expecting a total eclipse of the sun.

Owing to the fact that there is no atmosphere of any consequence enveloping the moon to reflect the solar beams and thus produce twilight and the dawn of the morning, there was not yet any light about us save that reflected by the earth, and a very faint glimmer of zodiacal light in the black eastern sky to herald the approach of day.

At thirty-eight minutes past two o'clock the cromosphere appeared, marking with a beautiful red glow the summits of the towering peaks of the Apennines and giving them the appearance of islands of light floating in a sea of gloom.

Everywhere that sunlight was spread over the moon's surface there was no blending of colors but, instead, sharp outlines of light and shade, which gave the landscape an awful appearance.

Presently the rim of the great luminary appeared from the black horizon and darted his bright untempered beams upon the mountain tops, crowning them with dazzling brilliance, while their flanks and the valleys were yet in utter darkness.

All of a sudden the blue rays of light so strong that our eyes could not endure them darted from the distant horizon and cast a tinge of blue over all the mountains; and, as the summits caught the sunbeams, insulated spots rose up rapidly on all sides of us.

It was about one hour from the time the first glint of the sun's upper edge appeared until his whole disk was in sight.

This great luminary did not at all appear natural, but seemed like an electric arc in the sky, a gigantic lamp of glittering blue; and the general tone of the sunlight over all the wild landscape about us was also blue.

And to add to the desolate and awful appearance of the scenes about us the slopes of the ragged mountains went down abruptly and rose on the opposite sides of the sharp valleys at startling angles of inclination to reach the crest of the parallel ranges.

The brilliant lighting of the summits of the subsidiary peaks and the crests of subsidiary ridges with the different colors of light served to increase by contrast the prevailing darkness in the lowlands, places which the sunlight had not yet reached; and the long shadows of the peaks and the ranges everywhere in silhouette on the sea floors had an awful blackness.

In short, there was all about us both far and near the violent contrast between the intense brightness of insulated parts and the deep gloom of those yet in equally intense shadow.

A very strange aspect of the heavens at this time was that as the sunlight went leaping the valleys, the craters, the ranges from crest to crest, and the peaks from pinnacle to pinnacle, the stars even near the edge of the sun's disk and close to the horizon all around remained extremely bright amid the sun's blaze.

The dark though star-lit sky helped the violence of the contrast, for the bright mountains in the distance stood forth upon a background formed by the blackness of inter-stellar space.

There being but little atmosphere to diffuse the solar light, there is no twilight or dawn going before a lunar sunrise to herald the approach of day. For the same reason there are no perceptible winds, no clouds, no

storms, no rainbows, no gorgeous tintings of the heavens, and no delicate shadings and soft blendings of colors; but, on the contrary, only sharp outlines of light and shade.

When the sun comes up, he bursts instantly into day and his fiery disk stands out distinct against the background of the sky; and after a fortnight's glare he as suddenly gives place to night.

The visible effects of these natural conditions about us were in every sense truly unearthly and terrible.

The hard, harsh, glowing light and pitchy shadows; the black noon-day sky with the glaring sun ghastly in his brightness; the absence of all signs of life save that of the long-since expired volcanoes; and, in short, the total absence of every condition in nature that gives tenderness to an earthly landscape—all these things conspired to make up a scene of dreary, desolate grandeur that is scarcely conceivable by an inhabitant of the earth.

At the strong solicitation of all, the captain agreed to remain two days in the Wolf Mountains. The object in so doing was to observe what in the way of natural scenery on the western slopes of the mountain ranges and on the floors of the adjacent seas the sun on rising higher in the sky would reveal.

On the morning of Dec. 25, Christmas Day, we left the refuge of the ship and again walked out on luna firma for a tramp and a climb among the peaks. This was the first time we had been from under cover of the ship since the sun rose.

This great luminary now appeared to be about two hours high, sufficiently well up in the sky to illumine the western slopes of the Wolf Mountains and a narrow

strip along the western border of the broad valley lying east of us.

For perhaps an hour we tramped along the crest of the range on which our ship was perched, in a blaze of untempered, pitiless sunshine, while our feet were freezing on the rocks beneath us. Several times I was forced to lower myself into the dark shadows of the mountain craggs to escape the merciless heat of the sun's rays.

The sun now being well up in the sky, we were able to see distinctly objects sixty miles away. The most distant things within our scope were as distinct to our vision as those very near us. And because there is not, on the moon's surface, any aerial perspective, we were not able at first to form very true conceptions of the remoteness of objects.

The sunlight spread over all the landscape gave us a broad scope in all directions and revealed many strange and interesting objects in wild and rugged nature, which greatly increased within us the true spirit of exploration with a view to satisfying curiosity and to gaining scientific knowledge.

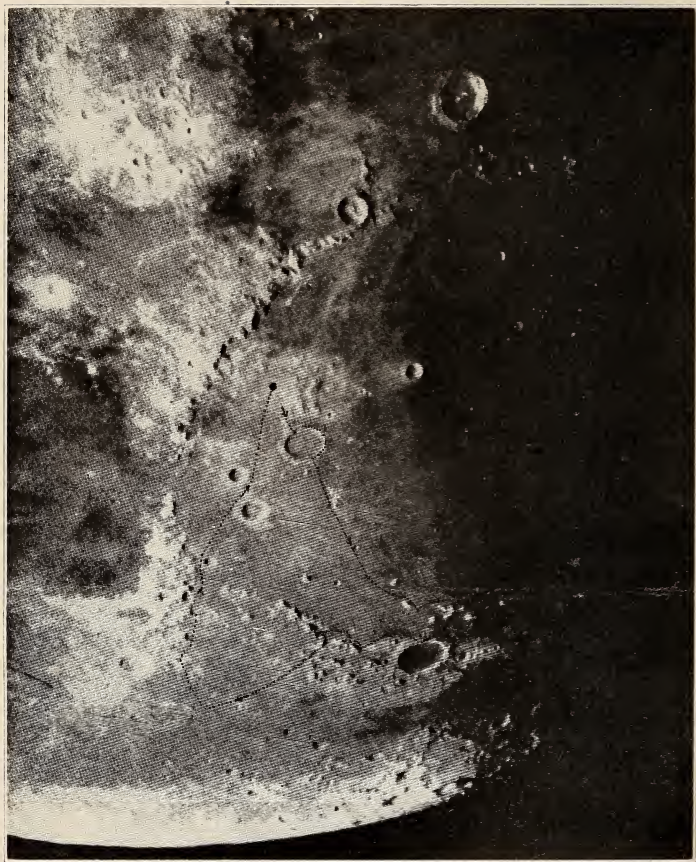


FIG. 35

(Paris Observatory.)

FIG. 35. PART OF THE SHORE OF THE MARE IMBRIUM.

The dark, smooth area occupying the right in the picture is the Mare Imbrium. The large vulcanoid with a dark floor, near the lower margin is Plato. The white, solitary peak a half-inch directly above Plato is Pico. Upward to the right of Plato are the Teneriff Peaks. About one inch to the left of Plato and extending downward to the left, directly across the Alps Mountains the Alpine Valley is faintly shown. (See Fig. 36). Farther to the left are the Caucasus Mountains extending from the vulcanoids, Aristoteles and Eudoxus, upward to the Palus Putredinus. To the right of this strait are the vulcanoids Archemides, Aristillus and Autrolycus. To the left of this strait out upon the floor of the Sea of Serenity is a faint white spot that marks the site of the problematical Linne. The long curved range of mountains extending from the Palus Putredinus upward to the right is the Apennines. The symmetrical crater at the upper terminus of the Apennines is Eratosthenes. The very large vulcanoid far out on the floor of the Mare Procelerum, in the upper part of the picture, is Copernicus. Downward to the right of Copernicus are the Carpathian Mountains.

CHAPTER XIX

TO THE APENNINE MOUNTAINS IN A BIPLANE

Late in the afternoon of Christmas Day, after forty-eight hours of wonderful glimpses and delightful experiences in the Wolf Mountains, we returned to the spot in the valley where our ship was first moored.

On the following morning, Dec. 26, the biplane was ordered out, and Profs. Brunor, Purnell, and Knowlton set it up. Within less than two hours after the work was begun these skillful machinists had placed all the parts together so as to form a strong, complete, and harmonious whole. Then the great winged craft was equipped in every way for a flight, after which Prof. Thorsen named it the **Petrel**.

About sixty miles away, in a course almost due southeast, steeps unscalable, and wild and bare to the distant view, loomed up in huge, rocky masses high above the arid plain. Toward this craggy fortress of nature we directed our flight.

With seven members of our party, Capt. Ewald, the Rev. Mr. Merritt, Prof. Galvan, Dr. Wharton, Mr. Waite, the writer, and aviator Knowlton, the great machine, though panting in the effort, steadily rose to an altitude of two thousand feet, a height sufficient to

place us clear of the moderate reliefs in the valley beneath us and to enable us to see our way clearly; and within thirty minutes the biplane came gently to the surface at the base of this mighty and picturesque mountain group.

At the end of the flight the first thing that engaged my attention and interest was the rugged, wild, and desolate grandeur of the huge mountain mass with its dozens of cold, blue, flinty-looking peaks which Profs. Monahan and Galvan estimated to be from three to five miles high; and the altitudes of these needles certainly must be all that these most competent authorities claimed for them, for to me they truly appeared to be leaning against the firmament of the heavens, or even piercing the sky.

And they stood forth gaunt and naked, and like the hills, the valleys, and the plains everywhere, were, to all appearances at least, totally devoid of both vegetable and animal life.

For a great distance along the bases of the foothills of this great mountain system extends a huge rent in the surface. This tremendous cleft is ninety miles in length, from two to three miles in breadth, and in many places so deep that it is not possible, even by means of search lights, for one to see the bottom of it. In its serpentine course and its extreme length this great rift resembles, somewhat, a deserted river bed; but the fact that it is uniform in neither length nor breadth stands as competent evidence that it owes its origin to some other cause than that of running water.

Against the base of the mountain range a short distance from this fissure rises a precipitous cliff many miles long and overhung by a thick strata of rock. This projecting strata is supported by dozens of mas-

sive columns resembling very much those of Luxor and of ancient Thebes. These giant columns somewhat cylindrical in shape are from thirty to sixty feet in diameter and appear to be more than two hundred and fifty feet in height.

As I gazed upon these supports of stupendous proportions, I observed in them also a very close resemblance to the three ancient orders of Greek architecture—the “severe” Doric columns, the graceful Ionic columns with their spiral volutes, and the ornate Corinthian.

But they are far more colossal than any of these orders, or than the historic monoliths of Santa Sophia, Pompey’s Pillar, or the “eternal mountains of Karnak”; but unlike any of those magnificent works of art, they are wholly the work of nature, which makes them all the more grand.

The contrast of light and shadow and of heat and cold were still amazing; and to prevent our hands and faces from blistering we were either forced to wear gloves and to shade heavily the observation windows in our helmets, or to remain most of the time concealed from the sun’s rays by keeping ourselves well within the dark shadows of the mountains.

While on this short trip we had many experiences wonderful for both the wholesome entertainment and the valuable scientific knowledge they furnished us.

We returned to the ship at one o’clock p. m. after having been out five hours, with greatly increased desires to push with vigor the work of exploration with a view to sight-seeing and to scientific investigation.

Until the morning of Dec. 27 we all remained at the ship. During most of this time Capt Ewald and Profs.

Galvan and Rider, who are recognized as being among the ablest selenographers, were attentively engaged at looking over and studying some very recent maps and photographs of the moon, which they carried along, with a view to determining the bearings for the next objects of study to be visited.

CHAPTER XX

FROM THE APENNINE MOUNTAINS TO PLATO via ARCHEMIDES, PICO, AND THE TEN- ERIFF PEAKS

The next main object of interest and study to be visited was Plato, a great ring mountain in the vicinity of the north pole. Profs. Monahan and Galvan especially were deeply interested in this sidetrip, and insisted on making it because Plato is one of the places on the moon where their then-recent observations and study as directors of astronomical observatories had discovered indications of what they thought might possibly be some forms of lunar life.

Early on the morning of Dec. 27, we were commanded to get ourselves in readiness at once for the long flight. And exactly at four o'clock a. m. the Petrel, loaded to its utmost capacity and under the guidance of Aviator Thorsen, rose to an altitude of seven thousand and one hundred feet and sped away to the north above the floor of the Mare Imbrium or the Sea of Rains, closely accompanied by the ship bearing the remainder of the party and all their equipments.

The name sea has been given to the separate clouded areas on the moon's surface, which, when seen from the earth, are plainly visible to the unaided eye. This name was assigned to these dark areas because when the study of selenography was practically in its infancy they were thought to be large bodies of water. But they are not seas; and if they ever were, not a drop of water in any form rests upon their floors now.

These so-called "seas" are simply extensive lava beds, and their surfaces are generally of about the color and consistency of emery stone; and besides a very limited number of low, small, bleb-shaped eminences varying in circumference from three to ten miles, the only "islands" found within their borders are a few small crater rings, some isolated mesas, and a scatter of solitary peaks.

All the seas are more or less rolling like most of our prairies; and often winding chains of low hills and huge crack-like ravines are everywhere visible in them, while their "shores" usually present endless successions of peaks, volcanoes, and fire-scarred cliffs.

In about thirty minutes after we began the flight, Archemides, a giant ring mountain fifty miles in diameter, hove in sight; and within twenty minutes more we were directly above its south wall.

The massive ramparts of this great natural structure has an altitude of seven thousand feet, is beautifully terraced, and contains much detail, both within and without.

As this was the first great vulcanoid we had seen at close range and under the sun's illumination, Prof. Thorsen in order to give us some excellent glimpses of its details followed its rim for one hundred and twenty miles.

As we were approaching this enormous crater there was nothing to which I could so aptly compare it as the jaw bone of some monster thickly set with tusks; and as the Petrel sailing at the tremendous speed of more than two miles a minute skimmed along almost touching the sharp summits of the cold, blue peaks which crown the crest of its encircling ramparts, the prodigious wall thickly studded with sharp-topped needles passing rapidly beneath us reminded us very much of a band saw on a stupendous scale running at high speed.

We were almost forty minutes traveling a little more than half its circumference.

About six o'clock we came upon a beautiful, unnamed group of mountains one hundred and forty miles north of Archemides. This structure in general is almost in the shape of the letter Y, and the crests of the ridges extending outward in the three directions are almost solidly capped with peaks whose summits are as white as the chalk cliffs of Dover or as the new-fallen snow, and which rise from five thousand to six thousand feet above the floor of the Mare Imbrium.

At twenty minutes past eight o'clock we came suddenly upon a solitary peak thirty miles in circumference at its base, standing out upon the desolate plain a monument to the ages.

Upon our first observing it, the Petrel appeared to be soaring far above its topmost pinnacle; but as we rapidly drew nearer, its summit, as if defying our approach, seemed to shoot upward into the black dome of the sky to an altitude of eight thousand feet.

For several minutes the biplane sped along just above one of the broad terraces on its western slope. Part of the time we were within the shadow of the peak,

which was so dark that we could not easily discern one another's features even at the short distance of five feet. This is a mountain of exudation, and the name of it is Pico.

At this isolated peak those of our party who had taken passage in the ship descended to the surface to make some photographs of some of the natural scenery in the vicinity of the mountain; but those of us who were on the biplane turned almost due west, and on account of the roughness in the details of the surface continued the flight.

After traveling a distance of about one hundred miles and passing a number of crater rings from one to three miles in diameter and from two thousand to five thousand feet deep we again directed our course almost due north.

Presently we found the Petrel skimming along near the bases of the Teneriff Peaks, a group of mountains of exudation, which rise almost abruptly from the surrounding lava plain to an altitude of more than eight thousand feet.

Continuing our course we landed at ten o'clock on a broad, smooth terrace three-fourths the way up the outer slope of the wall of Plato, where we made close connection with the rest of our party in the ship.

Here Capt. Ewald and a half dozen others including Dr. Wharton, and Profs. Monahan, Galvan, and Rider, hastily organized themselves into a special exploring party and sped away in the ship with a view to giving this particular spot as close inspection as the time set apart for this work would allow.

As soon as the ship disappeared over the ramparts of the mountain, the rest of us formed ourselves into an



FIG. 36. PICO, PLATO, AND THE ALPINE VALLEY.

The landscape presented here is the extreme southern part of the field shown in Fig. 35.

The large vulcanoid here shown is Plato. The beautiful, solitary peak about one inch directly above Plato, with a long shadow indicating that the mountain has three prominent points or needles is Pico. (See Fig. 37). The deep, straight furrow cutting downward to the left, across the Alps Mountains is the Alpine Valley.

(Nasmyth's "Moon.")



FIG. 37. AN IDEAL SKETCH OF PICO.

(Nasmyth's "Moon.")

exploring party to go on a climb among the towering peaks.

By means of a cord about one hundred and fifty feet in length we bound ourselves together in a long chain and at once began the steep ascent; and by twelve o'clock, noon, we had succeeded in reaching the crest of the mountain's rim and were gazing in wonder and astonishment into the yawning chasm which it incloses.

This vulcanoid has a diameter of sixty miles and the interior walls rise at an angle of about 45° to an altitude of seven thousand feet above its floor.

On account of the scarcity of time, the steepness of the declivities, and the great distance, we did not attempt to descend into the crater. From the crest of the encircling wall the floor of the crater appeared smooth, and of a very dark hue, and I saw distinctly near the center of the floor at least a half dozen crater cones extending upward from five hundred to one thousand feet.

The time during which the ship was gone on this side trip was a distressing period in the life of Dick Prouty, the colored man.

After the ship had departed Mr. Vanderlip led Dick to believe that the moon was inhabited by a strange people who never spoke audibly, nor smiled, and who were easily offended, and quick, strong, and violent in their resentments.

The impromptu dialogue which followed this news which startled Dick opened up as follows:

"Dick, three years ago Profs. Monahan and Galvan by means of a large telescope discovered right here in this mountain where we are now some signs of lunar life," said Mr. Vanderlip, "and they are almost dead certain to find some native inhabitants before they re-

turn from this side trip. And if they do, you've got to stand up with one of the fiercest-looking of the typical, Selenite women we can capture and let Brother Merritt here unite you and her in the holy bonds of matrimony."

"N-n-no sah, boss; nothin' doin' 'long that line," promptly replied Dick with quite a degree of emphasis and positiveness, "'cause you see I's already a married man and wants to do de right thing."

"You know, Dick, when Columbus discovered America," answered Mr. Vanderlip, "he took some of the native inhabitants back with him to Spain as evidence that he had discovered a new country inhabited by a strange people. If he had not done this, probably the people in Europe would not have believed his story. Now that is just what we want to do—take some of the natives of the moon back with us to earth as proof that we have been somewhere; and the way to do this is for you to get married and take your wife back with you."

"If you wants to do something to show whah you's been, some o' you white folks can dis tie up wi dat woman," replied Dick, clearly manifesting a rebellious tendency. "You see if I goes carryin' dat woman back wid me to Bellville dar'll sho be a bad mix-up wid the ole lady at home."

At half past one o'clock p. m. those who went away in the ship returned. They informed us that they had been entirely around the ramparts of the mountain, had descended to the surface at no less than a dozen places, and had discovered nothing whatever in the vicinity of this great ring mountain to indicate the presence of any forms of lunar life.

Immediately after the ship returned from this short cruise about Plato, we all went on board and descended the mountain slope to the point where the Petrel rested and hurriedly prepared and ate our noon lunch.

CHAPTER XXI

FROM PLATO TO THE APENNINE MOUNTAINS via MONT BLANC AND THE ALPINE VALLEY

At two o'clock the command was given to get ready for the return trip.

The biplane was at once headed southeast and quickly loaded with passengers to its fullest capacity. Then Prof. Knowlton took upon himself the grave responsibility of acting in the double capacity of pilot and engineer on this part of our tour, and thereby took into his own hands the destiny of all on board.

Just at this moment I was almost completely unnerved when I discovered that the Petrel was squarely facing a vertical cliff thousands of feet in height and not more than two hundred and fifty feet away.

"In what direction are you going to fly from this point?" inquired I.

"In the direction in which the machine is headed," came the prompt and positive reply from Prof. Knowlton.

"It furnishes me an extreme degree of transient enjoyment to sit in this biplane as it gradually rises from a level, smooth, and limitless plain to a great altitude," said I in response, "but I am not able to nerve myself

up to sit strapped in this machine and let it dash off the terrace and over the brow of that precipice with us."

"Being surrounded by all this grandeur, you should not let the thought of calamities beset your mind," replied the aviator, "but trust at every moment that everything will be well with us in all our ventures."

As he spoke these words he quickly drew my straps a little tighter and then mounted the machine. As the great winged craft went rapidly rolling in the direction of the abrupt declivity, he gave expression to the following:

"It becomes a necessity for us to take chances, and necessity is pretty closely related to duty.

So nigh is grandeur to our dust,

So near is God to man,

When duty whispers low, 'Thou must'

The youth replies, 'I can.' "

Just as he uttered the last word, this giant piece of mechanism with its burden of more than twelve hundred pounds plunged over the brow of the cliff, made a long swoop downward into the dark, immeasurable depths of the awful abyss beneath us, and sped its flight in the direction of the Alps Mountains.

This particular flight, in which the Petrel, now nicknamed "Old Trusty," broke all previous biplane records on earth for speed, was by far the most exciting and wonderful experience of my life.

For the first sixty miles our course was almost straight; and, as a result, our craft was almost on a perfect balance and the sailing smooth and delightful. We were moving very rapidly, but on account of the great altitude at which we were soaring I did not at the time realize the fact.

In forty minutes after our departure from Plato we reached the Alps at the most rugged and massive part of this great system and passed into its shadow. From this point we pursued a serpentine course almost parallel with the threadline of the main chain of this highland, which closely borders the Imbrium Sea, until we reached the entrance to the Alpine Valley.

On this last stretch of the course the Petrel in its sweeps around the shorter curves of the mountain range constantly and violently ducked and tilted, often standing on the ends of its wings at an angle of 45° ; and it was so swift in its flight that the crags and the spurs on the black faces of the cliffs appeared to go by us like cannon balls.

All the while I wondered if the aviator "had lost his head" and become desperate. Every time Old Trusty tilted, I thought we were gone; but each time, just at the critical moment, it seemed to give a forward lurch to level itself up again, and continued its record breaking speed. And immediately after each "close call" the aviator without speaking a word would slowly turn his head and look at us pleasingly through the observation window of his helmet, direct his sight straight ahead again, and give the biplane a little more speed.

And imagine, if you can, our environments: a million electric arcs almost at the blaze of noon shining down upon you from every direction with dazzling brilliance from a jet-black sky; the strange and lurid glare of the sun over all the rugged and picturesque landscape; the black, slaty-looking surface of the Mare Imbrium extending away to your right hundreds of miles beyond the farthest reach of the eye; the long, sharp, black shadows of the mountains lying out upon the sea floor, away in the distance ahead; the dark, tomb-like chasms

in the subsidiary relief sections beneath you; in a bi-plane a mile above the lava sea and making more than two miles a minute and closely hugging the steep declivities and the inconceivable altitudes of an impenetrable mountain chaos at your left.

Such was our ride between the hours of three o'clock and four o'clock of this memorable afternoon, during which time the Petrel covered the distance of one hundred and thirty-eight miles which separates Plato from Mont Blanc.

Although this particular stretch of the afternoon flight seemed to me to be a most reckless and desperate one, I did not, for some reason or other, become very much alarmed at the dangers to which we were exposed.

Perhaps the high degree of composure and daring spirit manifested by the man who held our destiny in his hands had much to do with reconciling me to the perilous position in which we were placed. And the immediate psychic effect of the awful silence that constantly prevailed about us, of the strange and wonderful aspect of nature, and of my consciousness of the skill and the wisdom of the Creator displayed in the harmonious revolutions of the mighty spheres in the heavens that bended above us, in some mysterious way appeared to nerve me up and to make me equal to the task.

In short, it is entirely beyond the reach of any human language to picture the scenes of solemn, silent grandeur that presented themselves before us in whatever course I directed my gaze; therefore, it must be left almost wholly to the intellectual resources of the reader to arrive at a full realization of what our surroundings were.

Finding the floor of the sea at the base of Mont Blanc highly favorable to making a landing, the biplane was brought to the surface. Here we waited for further orders from the captain of the ship and from the selenographers. Within five minutes after the landing was effected, while we were proudly stepping around on *luna firma* and exulting over the great feat we had just performed, the ship, bearing the rest of the party, descended to the surface from a point almost directly over our heads.

Mont Blanc is a rough, precipitous mountain of exudation which lifts its summit twelve thousand feet into the dome of the sky.

At the base of this, the most remarkable peak of the lunar Alps, the Alpine Valley opens out, a fantastic gap stretching away to the east in a straight line far beyond the ken of vision. In other words, this gap is a gigantic furrow, and the most conspicuous depression ordinarily classed in this group, cutting straight across the center of the Alps Mountains and connecting the Mare Imbrium with the Mare Frigoris, or the Sea of Cold.

This wonderful depression is eighty-five miles in length, from two to six miles broad, and its walls are approximately six thousand feet high and almost vertical. Its floor is generally level and thickly dotted with small crater pits, and strewn with detached stones of various sizes and shapes and with fragments of meteoric bodies. (See Fig. 36.)

After a stop of thirty minutes at the base of Mont Blanc, this towering sentinel which seems to stand guard at the entrance to the Alpine Valley, we passed into this huge furrow. A steady sail of one hour brought us within view of Aristoteles, a ring mountain



FIG. 38

(Yerkes Observatory.)

FIG. 38. ARISTOTELES, EUDOXUS AND
SURROUNDINGS.

The two large vulcanoids just beneath the center of the picture are Aristoteles and Eudoxus. The Caucasus Mountains occupy the center of the picture. The dark, smooth surface in the upper part of the picture is the Sea of Serenity. A part of the Imbrium Sea is seen at the right. The highlands in the upper, right-hand corner is a part of the Apennines. The broad strait separating the Caucasus from the Apennines is called the Palus Putredinus. The white spot on the floor of the Sea of Serenity, to the left of the strait, is the site of the Problematical Linne. In the lower, right-hand corner of the picture the Alpine Valley is seen opening into the Mara Frigoris.

sixty miles in diameter and with a wall eleven thousand feet high and beautifully terraced.

At this point we turned almost due south and continued the homeward flight above a wild, desolate region embracing perhaps fifty thousand square miles.

After we had passed over perhaps a hundred linear miles of this rough region, I perceived far to our left the outer slope of Eudoxus, a large, irregular vulcanoid forty miles in diameter. Although we were just at this time soaring at a great altitude in order to stay clear of the peaks, I was not, from our viewpoint, able to see the floor top nor the inner slope of its rim; but on the outer declivity I discerned many buttresses and projections, and observed that the crest of the encircling ridge is crowned with many peaks, one of which shoots upward twelve thousand feet above the level of the adjacent sea.

At seven o'clock, one and a half hours after we discovered Eudoxus, Old Trusty was speeding along at the rate of one hundred and twenty miles an hour almost within the shadow of the range of the Caucasus Mountains, one of whose peaks has an altitude of nineteen thousand feet.

At eight o'clock we passed between two large, picturesque, crater rings—Aristillus at our right and Autrolycus at our left. The former is a hundred miles in circumference and its tallest peak has an altitude approximating twelve thousand feet, while the latter is eighty miles in circumference and nine thousand feet in height.

At nine o'clock we reached the point from which we took our departure at four o'clock in the morning.

With the exception of a stay of three and a half hours at Plato and a stop of thirty minutes at the en-

trance to the Alpine Valley we were on a flight throughout the day and traveled about fifteen hundred miles.

During the day thousands of square miles of wild and barren area came within our scope and presented excellent glimpses of three great mountain systems, a half dozen vulcanoids with diameters ranging from thirty to sixty miles, and the full breadths of two lava seas with their tiny crater pits, their isolated mesas, and their solitary peaks.

This was the close of the sixth terrestrial day of our sojourn on the moon, time sufficient to give us a practical demonstration of the fact that the earth presents to lunarians exactly the same phases that the moon presents to the inhabitants of the earth—new earth, first quarter, full earth, third quarter, and new earth again—except that the phases are in a reverse order. When the inhabitants of earth have a new moon, lunarians have a full earth—a bright full-orbed moon with fourteen times as much apparent surface as ours.

At this time the sun was apparently about 50° above the eastern horizon; or, as we commonly say, "about four hours high." Its intense and sickening heat and bright light were becoming almost past endurance. For this reason our medical adviser and "family physician," Dr. Wharton, and others, recommended and advised that we tour the moon from east to west and travel sufficiently far each day to keep the sun's position, with respect to our location, near the eastern horizon. They thought that by so doing we could easily avoid both the intense heat of the sun's vertical rays during the long lunar day and the extreme cold of the equally long lunar night, and yet have constantly both, the light and the heat of the low sun by means of which to travel and to explore.

This advice was followed out. The moon being about six thousand and eight hundred miles in circumference, we were forced to travel each day, on an average, about two hundred and thirty-five miles, in order to complete the circuit of the moon in a month. We easily traveled the required distance each day, and yet had an overabundance of time in which to make long side-trips in the biplane.

At half past nine o'clock p. m. we ate our evening meal, and thirty minutes later retired for sleep and rest.

CHAPTER XXII

FROM ARCHEMIDES TO COPERNICUS via THE APPENNINE GORGES AND ERATOSTHENES

At five o'clock on the morning of Dec. 28, the day following our return from Plato, we took our departure for Copernicus by way of the Apennine gorges and Eratosthenes.

The selenographers rose at three o'clock in the morning and held a consultation among themselves. The rest of us were called at half past four, and a few minutes later breakfast was announced. While we partook of this repast the scientific men who had been holding the meeting stated that those of us who could withstand the exposure and were willing to face the unavoidable dangers that would beset us on every side might, if we desired, travel in the biplane and that the rest might take passage in the ship.

Owing to the novelty of it and to the excellent, unobstructed views it afforded I chose the former mode of travel.

The lava seas and their embayments are pretty generally rolling like most of our prairies, but extremely rough in their minor details.

Hard, flange-like projections in the form of ridges only a few inches in height, with sharp crests as hard as cinder, extend in serpentine courses about over many parts of the surface. The surface is characterized also by other varieties of details in the form of tiny crater pits varying in diameter from eight inches to five feet, and by as many very small bleb-shaped eminences.

Large quantities of detached stones, due most likely to the great extremes of heat and cold, often lie in heaps in the valleys and the ravines adjacent to the cliffs, and fragments of meteoric bodies cover the seas.

All these barriers at once made it clear to every one that the auto, which had been carefully packed and taken along, could be of no service to explorers in a world like our satellite; therefore, this conveyance was completely abandoned and left behind.

The members of our party readily agreed as to the next objects of interest and study to be visited, but were divided among themselves as to the particular course to be pursued to reach them and disputed with one another in a spirited but friendly manner.

Some desired to pursue a course parallel to the eastern "shore," or border, of the Imbrium Sea and fly near the western slope of the Apennine Mountains until we reached Eratosthenes, while others wished to cross this great highland system by following the mountain valleys and gorges in order to catch some glimpses of its scenery.

The controversy on this point was concluded by Profs. Monahan and Knowlton as follows:

"This great system of the Apennines is four hundred and sixty miles long, one hundred and seventy miles in extreme breadth, and has dozens of peaks whose alti-

tudes range from eighteen thousand to twenty-six thousand feet," said the astronomer and selenographer, "and is the most massive and extensive of the reliefs on the visible hemisphere of the moon. The latest photographs of the moon, and astronomical observations made under the most favorable condition in every respect reveal the facts that some of the mountain valleys are very deep and comparatively narrow, while others are shallow and have barriers to progress; and all of them zigzag abruptly and often in their courses. These existing facts considered along with the extreme tenuity of the atmosphere in the greater altitudes will make your flying very difficult and render the conditions highly favorable to wrecking the machine or to hanging up indefinitely in the mountains. Even when the surface beneath you is smooth and your sailing clear, imminent dangers lurk unthought of about all heavier-than-air machines propelled by means of gasoline or storage batteries."

"I am to drive and guide the Petrel in this flight," replied the aviator, "and I have sufficient faith in myself and the machine to boldly make the venture although it may, as you say, prove to be a perilous one."

The course through the mountains was finally agreed upon.

It was arranged for the Petrel to lead in the flight and for the ship to follow closely in the rear in order to be in a position to render immediate assistance in the event of a wreck. It would have been absolutely comfortable and safe for all to have taken passage in the ship, but for the reasons previously stated many preferred to travel in the biplane.

Perhaps it is in place to say here that the moon has magnetic poles and that the needle of the compass

promptly and vigorously responds to them, and that this instrument was wholly reliable and without price to us in our travels and researches.

The promoters of this great expedition as stated in a foregoing chapter, were mathematicians, astronomers, and selenographers of renown, and ready and competent to produce at a moment's notice, by means of a supply of photographs and key maps of the moon's visible hemisphere, and by means of the compass, the courses of and the distances to, all objects of study and interest.

Exactly at five o'clock Capt. Ewald handed the aviator a large key map of the region over which we were to fly that day, containing thereon a scale of miles and bearings of the compass to govern him in his flight, and spoke as follows:

"So far as I know there is nothing more to detain us at this point; so you may wing out, Knowlton, when you are ready."

The aviator quickly sprang to his feet and, cutting his eyes fiercely but pleasingly at those about him, called out in the following words:

"All aboard the Petrel for Eratosthenes and Copernicus."

Four of us besides the aviator took passage in the biplane, and within two minutes after the call Old Trusty was again winging its desperate flight in the direction of destination. In about three minutes after we started I looked back and saw the ship rising high into the dome of the sky.

After we had traveled almost due south above a moderately smooth surface for about two hundred miles, the aviator, taking the chances of barriers in the ser-

pentine valleys and gorges, turned recklessly into the great system of the Apennines.

And truly these so-called gorges are rather clefts or rents in the surface, which generally follow courses almost parallel with the threadline of the valleys, but sometimes make abrupt turns and cleave the mountain chains and the valleys at almost right angles.

As the biplane skimmed along I noticed that the floors of the great rifts were strewn or covered with stones of every conceivable size and shape heaped in infinite confusion, and that the stupendous, continuous cliffs to our right and to our left were as dry, or free from moisture, as a brick-kiln.

No sooner would we merge from one maze of mountains and shoot across a valley than we would dart blindly into a gorge of another parallel range of the system.

As time wore on and my attention was called in rapid succession from one scene of desolation and destruction to another, I wondered seriously if we should live to return to earth to tell the story of our travels.

I truly believed at this particular time that I had had a presentment that there was impending danger of some kind or other just ahead—that we would either wreck on some angle or short curve in our wild, mountain flight, or run blindly into a rendezvous or a colony of Selenites and at their hands meet a cruel death.

After traveling about sixty miles in this cold, dry, and forsaken highland, I saw through a last upheaval of a defiant mountain range a narrow opening towards liberty; and presently the Petrel shot into the open high above the floor of the Mare Nubium, or the Sea of Clouds. Here we turned almost at right angles due west.



FIG. 39. COPERNICUS AND SURROUNDINGS.

The level, smooth area in the lower part of the picture is the Mare Imbrium. This sea is bordered on the left by a part of the Apennines. The vulcanoid marking the terminus of this mountain chain is Eratosthenes. The large vulcanoid above and to the right of the center of the picture is Copernicus. The jet-black, circular spot in the lower, left-hand corner of the plate marks the point of our arrival on, and departure from, the moon. (See Figs. 30, 32, 34, and 35).

(Yerkes Observatory.)



FIG. 40. COPERNICUS.

(Nasmyth's "Moon".)

Sixty minutes more brought us to Eratosthenes, a symmetrical vulcanoid thirty-two miles in diameter and with very steep slopes. Its walls rise eight thousand feet above the floor of the adjacent seas and sixteen thousand feet above its own floor.

We had an excellent view of this beautiful, natural structure. We did not come to the surface at this point, but continued our flight for copernicus two hundred miles ahead.

One hundred miles beyond Eratosthenes we crossed a broken line of small crater pits extending from north to south a distance of one hundred and twenty miles, and verging at either end into a narrow crater valley. The apertures of these long-extinct volcanoes, from our elevated view point, reminded me of a long chain of uncapped coke ovens.

Our approach to Copernicus was grand beyond description. A few minutes after we crossed the line of crater pits, while Old Trusty was soaring at an altitude of two miles, I beheld in the distance ahead a vast region of the wildest volcanic desolation. Here craters from one mile to five miles in diameter crowd together in such countless numbers that the surface as far as the eye can reach looks frothed-over with them. And away to the northward run several great chasms a mile wide and of appalling blackness and depths. (See Fig. 40).

Presently the stupendous ramparts of Copernicus hove in sight; and one of the first things I observed was a pale-blue spot in the sky about the size of an inflated toy balloon slowly shifting its position among the towering peaks of this great ring mountain. It was our ship bearing the rest of our party.

On a nearer approach to this enormous vulcanoid I observed crag rising on crag, and precipice upon precipice, mingled with craters and yawning pits, towering pinnacles of rock, and piles of scoria.

Within twenty minutes more the Petrel was almost against its wall.

Although the biplane was a little more than two miles above the floor of the Mare Nubium, we were yet compelled to look upward along a slope of 60° or 75° to a height of more than three thousand feet to see the slender peaks, forests of rocky steeps, columns, minarets, and giant obelisks that crown the crest.

All these masses of dazzling blue jammed together in great profusion and standing out against a dark background all spangled with stars formed a grand panorama that seemed something unreal.

Several attempts were made, without success, to pass over the encircling wall in the biplane. Finally we were forced to descend to the surface of a terrace on the outer slope two thousand and seven hundred feet below the crest of the rim which we afterward succeeded in reaching after a climb of two hours.

At eleven o'clock, after having traveled in all a little more than five hundred miles, we stood on the crest of the north wall of Copernicus, one of the grandest of the lunar craters located exactly on the tip of the nose of the "Man in the Moon."

This great vulcanoid named in honor of Nicholas Copernicus, a celebrated German astronomer, is about sixty miles in diameter, and its ramparts rise twelve thousand feet above its floor.

From the central part of this deep, bowl-shaped depression rise three peaks in pyramidal form, the tallest of which has an altitude of two thousand and four hun-

dred feet; yet, the basin in which stands this little mountain group is in every way so immensely large that, to an observer standing on the crest of its ramparts, this relief appears to be nothing more than a cluster of tiny hillocks.

Copernicus is not really the monarch of all ring mountains, but its comparatively lone situation gives it an appearance of solitary grandeur belonging to no other single formation on the moon.

The whole area for many miles around Copernicus, when viewed from the crest of its rim, exhibits many most interesting types of structures.

Fifty miles away to the north, the tall, sharp, snow-white peaks of the Carpathian Mountains forming the southern border of the Mare Imbrium presents one of the grandest sights that ever met my gaze.

CHAPTER XXIII

FROM COPERNICUS TO TYCHO, via MURUS RECTUS, OR THE “STRAIGHT WALL”

At twelve o'clock, noon, we took our departure for Tycho, a large crater of the ring-mountain type located about eight hundred miles almost due south of Copernicus and near the center of one of the wildest regions on the face of the moon.

On account of the particular location of this stupendous structure with respect to a fancied picture of a stylishly-dressed lady on the moon's disk, and of its being the center of a great and mysterious ray system, it is known in myth as the “flaming jewel” that the Moon Maiden wears on her throat; but in the science of selenography it is known as Tycho, a name given in honor of Tycho Brahe, a celebrated Danish astronomer.

Although this object of interest was a great way off our “trunk line,” which corresponded in a general way to the moon's equator, every one showed a decided inclination to make liberal sacrifices in order to see this marvelous relief.

Owing to the facts that the distance was long, our time limited, and the surface undulations of the districts in the vicinity of Tycho great and exceedingly

rough, the biplane was temporarily abandoned and left behind and passage was taken in the ship at a great altitude and a high speed.

At one o'clock we reached Murus Rectus. This escarpment familiarly known as the "Straight Wall" and the "railroad" is the most extensive fault on the moon's visible hemisphere.

The cliff extends from north to south a distance of sixty-five miles, is nearly straight, and rises almost vertically to a uniform height of two thousand and five hundred feet.

Several of us traveled on foot along the base of this continuous precipice for some two miles. We found the surface within the confines of our vision hard, smooth, and gently rolling, and almost wholly free from all forms of minor details except a few small crater pits whose diameters range from five hundred to one thousand feet.

After remaining thirty minutes at Murus Rectus we again pursued our journey.

We reached Tycho at half past three o'clock in the afternoon, and found this projecture to be a steep, smooth, symmetrical ring mountain fifty-four miles in diameter with a floor seventeen thousand feet below the crest of its rim, and with an irregular central peak rising abruptly to an altitude of five thousand feet.

In some respects this giant prominence surpasses Copernicus in a point of grandeur but is robbed of much of its splendor by being in a jam with the craggy and stupendous reliefs of a region apparently only fit for demons.

At the first glimpse of this titan among lunar structures I readily observed that it, like the rest of its class

of eminences, owes its origin and existence to the agency of heat.

As the ship slowly descended from an altitude of thirty miles, to the crest of the mountain, I discerned a number of "rills" or rents of enormous proportions, which cleave the ring at right angles and extend off in straight lines until they become lost in the canyons and the dismal shadows of the reliefs in the solitudes of the rueful wilderness.

I observed also during our descent a number of well-defined but shallow, troughing valleys from twenty to thirty miles in breadth, extending outward from the ring in the manner of spokes from the hub of a wheel, far beyond our range of vision.

Immediately after the landing had been effected the selenographers set about inspecting the details of the valleys, the mountain ring, and other relief forms adjacent thereto and making both physical and chemical examinations of the rocky substances of which these structures are constituted.

After the inspection and the tests had been made, Prof. Galvan spoke as follows:

"Under a high sun and a forty-inch refracting telescope this vulcanoid, like a luminous body, appears to emit light to a great distance, intersecting all this rugged region about us; and even under the sun's present angle of illumination I have observed from the earth, by means of a powerful telescope, streamers of light following intensely the courses of these broad valleys for more than a thousand miles. But this phenomenon does not manifest itself to us now. Like the mirage, it withdraws itself at a short range of view. If we were now on earth and viewing our satellite under a high magnifying power and most favorable atmos-

pheric conditions, this mysterious ray system would present itself in all its richness and beauty. But in all our researches we discover no assignable reasons why this mountain should be the center of a great ray system."

The immediate surroundings of Tycho present an appearance of grandeur far exceeding that of the mountain ring itself. The desolate and awful appearance of the massive reliefs, together with their infinite varieties of minor details which it is not possible for the most powerful telescopes and cameras to reveal defies description.

On the floors of the large crater rings, on the flat tops of the foothills, and on the low, broad terraces of the great elevations of every order stand countless small parasitic structures in the form of mesas. These little table lands have bases varying in circumference from two thousand to three thousand feet and rise at an angle of about 60° to an altitude of fifty or sixty feet.

These comparatively small eminences bear, in turn, a secondary set of parasitic structures of a bleb-shape, which usually rest on circular bases from fifty to a hundred feet in circumference and rise to an altitude of fifteen or twenty feet.

These little dome-shaped knobs usually have on or near their summits from one to three openings ranging from three to seven feet in diameter; and in every instance in which a cone is characterized by more than one vent, the openings are on the sides of the summit and "look off" at right angles to the slope of the eminence to which they belong.

Careful tests produced satisfactory evidence that these little eminences everywhere in the low-lands communicate freely with one another and with underground

reservoirs and lakes, by means of passages extending downward and to the sides for untold depths.

The roughly-circular vents at or near the summits of these tiny projectures resemble very much the mouths of geysers at their periods of rest. The dark-blue and the alabaster-like accumulations found about these openings are as hard and dry as concrete, and, when pounded on, ring like flint or steel.

If this class of parasitic structures with their shapely-defined vents are to bear testimony to the fact that the agencies of fire and water have been at work here, it seems perfectly safe to say that these extinct geysers have been inactive for untold ages.

On the elevated terraces and the upper slopes of all the greater elevations is still another class of parasitic structures entirely different from that roughly and briefly described in the preceding paragraphs.

The individual projectures belonging to this order stand on bases covering from one hundred to two thousand square feet, extend vertically upward to astonishing heights, and vary infinitely in altitude. They are invariably pyramidal in form, having anywhere from three to eight faces, but I thought of them, as I gave inspection, as being spires rather than drawn-out pyramids.

These gigantic monoliths stand everywhere in a jam, are numbered by millions, and collectively cover thousands of square miles of area.

The basilar extremities of these wonderful chimney-like structures are of a dark-gray color and as hard as flint rock, while their upper extremities are of the color and consistency, almost, of soft brick.

As I gazed upon these black-faced monoliths of mammoth proportions, I questioned concerning their origin



FIG. 41. MOON'S AGE TEN DAYS.

The large vulcanoid to the right of the center of the picture is Copernicus. The location of Murus Rectus or the "Straight Wall" is marked by the first angle in the course of our long southern tour. (See Fig. 42). Tycho may be identified as the deep, symmetrical vulcanoid about an inch below the upper margin of the picture. (See also, Fig. 45.) Newton marks the limit of this tour and may be seen in the extreme upper part of the picture, near the "terminator," or line of illumination.

(Lick Observatory.)



FIG. 42. MARE NUBIUM AND SURROUNDINGS.

The large vulcanoid near the lower margin of this plate is Copernicus. The dark line about one inch in length, at the angle in our course, in the upper part of the picture, is the shadow of Murus Rectus, or the "Straight Wall." (See Fig. 43).

(Lick Observatory.)

and wondered again if the agencies of fire and water had been at work in this region.

The captain of the ship caused the craft to soar at a vertical distance of three miles above the valleys and the canyons beneath us in order to give us an intelligent glimpse of this wonderful character of detail; and as the ship gently floated along the brows of the mountains, I looked upon these giant, dark-faced obelisks with millions of tons of rock heaped in great confusion about their bases, with intense interest. I felt inclined to believe they were the chimneys to the place of eternal punishment, and wondered if it were possible for the woeful regions of perdition to appear any less inviting.

The countless little bleb-shaped eminences, or knobs, with vents about their summits, resting on the mesas in the low-lands, when viewed collectively from an altitude of three miles and thought of apart from the eminences of other characters intimately associated, and often intermingled, with them, reminded me of a prairie-dog town in northwestern Texas or in New Mexico, on a stupendous scale. When observed and considered along with every other variety of formation within the sweep of vision, the whole region resembled the ruins of a limitless or continuous city on a gigantic scale after all the combustible matter had been licked up by the hungry flames of a great conflagration and the chimneys and the walls left partly intact.

In some respects this extensive region resembles a colossal honey-comb. And deep soundings of the vents of every order in the surface found no bottoms; and large stones which we dropped into these gaping apertures often awakened no echo.

The whole region extending for hundreds of miles in every direction from Tycho is one of mighty cataclysms

of appalling heights and depths, and is certainly a marvelous specimen of the lunar landscape—the most gruesome district on the face of the moon.

Prof. Galvan, the scholarly and talented young Irishman who was one of the scientific men of our party, compared this forsaken place to the Giant's Causeway, Ireland, the supposed ruins of the great bridge built across the English Channel by Finn McCull, the Irish giant, to make a way for a Scottish giant who had challenged him to come over to meet him in a "bout."

Mr. Vanderlip declared that this region in question appeared to him very much like the Mauvaise Terres of southwestern Dakota; but truly I do not exaggerate when I tell you that the sensation which the Giant's Causeway or the Bad Lands inspires is that of a little paradise in comparison with that which is induced by this particular region in this desolate and forsaken world—the moon.

I am truly tempted to say that if the Creator should see proper to place upon me after death and the Judgment a severe punishment for unrighteous living during my sojourn on earth, and any part of it should be left to me, I would pray Him to inflict upon me in His enforcement of Divine laws almost any punishment in preference to that of a life of eternal exile or imprisonment in the dreary solitudes of the canyons and the labyrinths in the regions about Tycho.

CHAPTER XXIV

FROM TYCHO TO NEWTON via LONGOMONTANUS AND CLAVIUS

After a stay of two and a half hours at Tycho we sped our flight for Newton, a ring mountain located about seven hundred miles almost due south of this point and very near the moon's south-pole.

The inducement that led the selenographers to extend this sidetrip on to Newton was the steep, lumpy, towering walls of this structure as presented under the telescope and a low sun.

Thirty minutes after we left Tycho I descried far in the distance ahead Longomontanus, an irregularly-walled valley ninety miles in diameter and with a floor fourteen thousand feet below the crest of its rim.

The inner slopes of its ramparts, I observed, were exceedingly rough and varied, and its floor was very uneven and dotted with many rough, irregular peaks and a great variety of other details.

As our ship floated along for some twenty minutes almost above the border of this great cavity, at an altitude of fifteen miles, we had an excellent, prolonged view of it in almost its entire length and breadth.

At seven o'clock we reached Clavius, the largest and in every way the most wonderful of all the depressions ordinarily classed under the head of walled valleys.

This titanic cavity is almost circular, is one hundred and forty-two miles directly across the center, and covers an area of sixteen thousand square miles; and two of the five, large crater pits lying wholly within the boundary of its floor are each twenty-five miles in diameter. It is twelve thousand feet in depth, and the plateau on the outside of its border is almost on a level with the top of its ring.

In other words, this depression is in every way so immensely large that its tremendous wall, if extended in a straight line, would reach from Nashville, Tenn., to Chicago, Ill.; and its floor is sunken so far behind those huge ramparts that the lofty wall which surrounded us as we stood at its center was at every point entirely beyond our horizon.

At half past seven o'clock we left Clavius and pursued the bearing leading directly to destination.

After a continuous flight of one hour and thirty minutes we reached Newton and our craft came gently to rest on a narrow terrace near the summit of this rough, towering relief.

This day had been one that called for an extra amount of physical exertion on the part of all, and one full of exciting experiences as well; and for these reasons the captain, instead of sending out at once an exploring party on foot as was his custom on reaching the end of a long flight, advised and urged that we hurriedly prepare and eat our evening meal, get everything in readiness for the next day's journey, and retire for sleep and rest.

At five o'clock on the morning following our arrival at Newton twelve of our number—all except Dr. Wharton, Mr. Shipley and Dick Prouty—bound together in a chain by means of a long cord began the ascent of the mighty mountain ring that towered one thousand and seven hundred feet above the terrace on which rested the ship. We reached the crest in a climb of two hours.

Newton appears in a photograph, or under a telescope of high magnifying power and a high angle of illumination, to be both circular and symmetrical; but it is neither. Its shape is somewhat that of an elongated ellipse; and its height is not uniform, the bulwarks in a number of places being breached half way to the base, and at least two peaks on the crest of its rim rising to an altitude of more than twenty-four thousand feet. The vertical distance from the summit of the tallest peak to the lowest point in the depression is almost five miles, a depth so great that neither earth nor sun is ever visible from a great part of its floor.

Newton is one of the most awe-inspiring of the great vulcanoids, challenging Copernicus and Clavius in all the points of magnitude and grandeur, and is the deepest known depression on the face of the moon.

While at this place Mr. Shipley, the stenographer, was the most despondent person I ever saw.

He expressed a sincere desire to return to earth and insisted that we depart at once for home. He refused to go out with the exploring party at Newton and retired to his bunk in the ship.

At Tycho, the day before, he was struck by a flying missile, and his thumb was almost severed from his hand. For two days he had not appeared very cheerful, and the injury he received at Tycho together with the tomb-like appearance that the great chasms took

on, due largely to the black shadows cast by a low sun, had perhaps much to do with precipitating his violent attack of despondency.

At twelve o'clock, noon, when we returned to the ship we found lying on the table a type-written letter bearing Mr. Shipley's signature. Because the wording of this message describes, in a sense, so completely the feelings that a rugged lunar landscape inspires when beheld for the first time, I quote it verbatim. It read as follows:

Newton, Luna.

Dec. 29, 1914.

Dear Friends:

There is such a sameness about all those lunar landscapes—always boundless plains, monstrous peaks, stupendous parallel mountain ranges, chasms and black shadows, or crater rings either with or without central mountain masses.

I am tired of those endless plains, towering summits, and countries of death and desolation. I want to see no more of those silent landscapes, black, tomb-like chasms, and frightful solitudes. Let us leave those barren deserts that life has quitted forever. Let us, I pray, fly at once from this world of eternal silence with its apocalyptic visions and its sepulchers that the Angel of Death has closed with icy hands and return to our earthly paradise.

Yours sincerely,

Warren N. Shipley.

Mr. Shipley was a stenographer of great merit and Capt. Ewald's private secretary. He was amanuensis for Profs. Monahan, Galvan, and Rider, also, and often took short dictations from the rest of us, for small

"tips," when not rendering services for his immediate employer.

Owing to Mr. Shipley's official relations to Capt. Ewald, it appeared to us that the great promoter of the Lunar Expedition was about to lend his influence in favor of an immediate departure for home; but when we took the vote on the proposition, both the captain and his official scribe were quickly overruled by an overwhelming majority.

Truly I have never been able to understand why Mr. Shipley could not appreciate the grandeur in all the wonderful landscapes that presented themselves at every point along our pathway. He was one of the brightest young men I ever knew, an excellent scholar, and a specialist, along some lines, without a parallel. Beyond the narrow limits of the particular work he was employed to do during the voyage he took comparatively no interest; while every one else, even to Dick Prouty the colored man, was able to discover in the wonderful views constantly about us during our tour of the moon plenty to stimulate to a high degree his curiosity and a lively interest in looking patiently and studiously into the details of this foreign and lifeless world.

Profs. Monahan and Galvan said that Mr. Shipley was, without doubt, struck at Tycho by a meteoric particle weighing perhaps not more than an ounce.

Immediately after this unfortunate event the study of meteoric bodies by means of direct observation was taken up by the astronomers and selenographers. In due course of time they discovered that the whole of the moon's surface had, during the past ages, been pounded all over by meteoric stones many of which, no doubt, weighed several tons and that most of the smal-

ler bodies heaped in the clefts, the gorges and the ravines and scattered over the floors of the ring mountains, the walled valleys, and the lava seas were originally the fragments of meteoric bodies.

Countless numbers of meteoric stones come to the earth daily. The resistance offered by the atmosphere converts them almost instantly into heat and light, and for this reason comparatively few ever reach the earth's surface; and those that **do** come to the ground produce a rumbling sound as if to give due warning of their approach. When thus set ablaze, they are called meteors or shooting stars.

Not a meteor ever flashes across the lunar sky. As there is practically no atmosphere about the moon to convey sound and to convert them into heat and light, these cold, dark, flying missiles approach the moon noiselessly, unobserved, and in perfect state and bombard the surface sometimes singly and sometimes in showers; therefore, a traveler on the moon knows nothing of their approach nor even their presence until they strike the surface with great force and the fragments fly off in all directions.



FIG. 43. ASPECT OF MURUS RECTUS, OR THE
"STRAIGHT WALL."

(Moreux's "A Day in the Moon," The Frederick A. Stokes Co., N. Y., Publishers.)

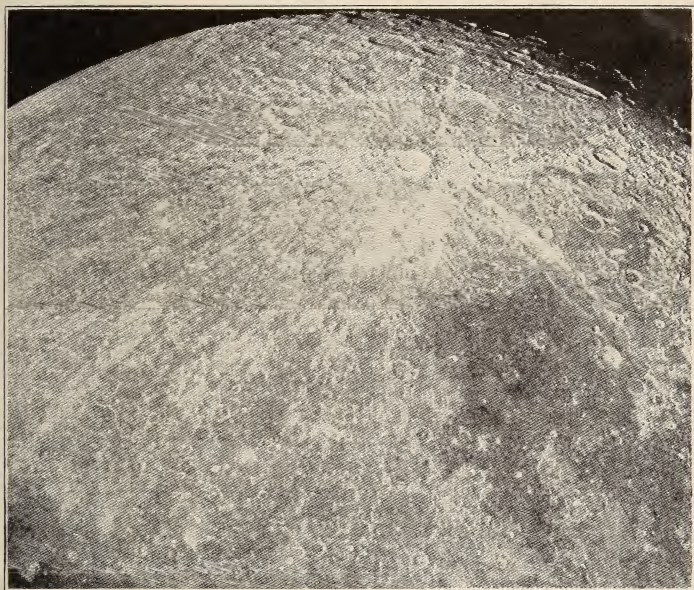


FIG. 44. ENLARGED VIEW OF THE RAY SYSTEM
ABOUT TYCHO.

This, the most extensive of the ray systems of the moon has its center in Tycho. The rays of this system should be compared with those which have their centers in Copernicus, Kepler and Aristarchus. (See Figs. 48 and 49).

(Yerkes Observatory.)

CHAPTER XXV

A THREATENED ENCOUNTER WITH SELENITES AT GASSENDI

At one o'clock in the afternoon of this same day we took our leave for Copernicus, by way of Schiller, Shickard and Gassendi.

From all points in the vicinity of Newton the sun is always seen far down on the northern horizon; and, as a result of a constantly low sun in this extreme polar region, the degree of cold is all the time exceedingly great.

Capt. Ewald and others gave it as their opinion that when we returned to gather up the equipment we had left temporarily at Copernicus which is located very near the moon's equator and was at this time under a pretty high angle of illumination, we would not be able to endure the intense heat at the surface and would on this account be forced to leave the biplane behind and to pursue rapidly our westward course at a great altitude and a high speed to escape the burning rays of the sun.

After traveling at the limit of our ship's speed almost due north for about one hour and forty minutes, I sighted in the distance ahead and to our right a tre-

mendous elevation which on our nearer approach proved to be a very large isolated ring mountain.

It was a long way off, and I could see only the outer slope of the wall next to us. Because our time was extremely limited, we did not vary our course to approach it but kept our bearing straight ahead. The selenographers informed us that this stupendous structure was Schiller.

At half past three o'clock, after having traveled in a direct line about nine hundred miles, our ship crossed the south wall of Shickard, a great ring plain challenging Clavius in all its magnitudes.

As this structure possessed no characteristics out of the ordinary except that of its immense size in every way, we did not descend to the surface at this point. After passing directly across the center of its floor and above its north wall, we changed our course and pursued a bee-line for Gassendi which is almost on the direct route from Shickard to Copernicus.

At five o'clock in the afternoon we reached Gassendi, a rough, elongated vulcanoid fifty-four miles in transverse diameter, and with a prominent central mountain mass and ramparts reaching an altitude of nine thousand and six hundred feet. Its wall is invaded on the north side by a crater ring eighteen miles in diameter, and terraced both within and without with the usual segmental ridges or landslips.

The neighborhood of Gassendi is diversified by a vast number of mounds and ridges of exudated matter and traversed by enormous chasms and clefts which exceed one mile in width and sixty miles in length.

After passing across the floor of this structure the ship descended and came to a position of rest on a smooth and level spot of surface in an exceedingly shal-

low, walled valley about forty miles north of the mountain ring.

Not many of the ranges and the peaks in the vicinity of this particular relief are on a scale so gigantic as those about Tycho and Newton, but the details are rough and varied in a degree and a way to make this one of the most dismal solitudes we were in at any time during our tour of the moon.

But the strangest, most interesting, and most exciting experience I had at any time during our travels on our satellite was a threatened encounter at this place with Selenites.

You are no doubt aware of the fact that the conduct of some of the members of every exploring party on all occasions like this one is such as to place not only their own lives, but the lives of all the rest of the party as well, in jeopardy, if not wholly at the mercy of the native inhabitants. This is just what happened to us on this particular occasion.

Immediately after the craft came to the surface, Capt. Ewald hastily organized the whole company, with the one exception of Prof. Rider, into an exploring party and commanded them as follows:

"Boys, come right along now with me, we are going out for a short tramp and a little climb among the foothills of the mountains. Our time is somewhat limited, and we must be back at the ship by seven o'clock."

Although the rays of the sun were blistering hot, when they struck us squarely, we promptly and hastily bound ourselves together by means of a cord and filed along after our leader by way of a lonely and unbeaten path through the dark shadows of the mountains cast in the narrow valley lying between two parallel ranges.

At the expiration of about ten minutes, during which time we were in a pretty lively trot, the captain suddenly called a halt and commanded us to ascend the mountain slope to our right.

Within fifteen minutes more we had worked our way up the steep acclivities to the crest of the squatty range of mountains of uniform height, which lay wholly within the shadow of a far more elevated range. We followed the crest of this ridge for perhaps a mile and then stopped, facing a series of stupendous cliffs one above another, just across the valley which we had left, rising by terraces at a slant of about 60° to an altitude of perhaps a thousand feet above the crest of the mountain chain upon which we stood.

These steep slopes were neither very even nor very smooth. And in color they were variegated, as revealed by the bright rays of a high sun reaching well down the declivities toward the level of the valley beneath us. In fact I recognized upon the faces of this series of inclines almost, if not quite, all the colors seen in the rainbow of the sky, in all their varying degrees of hue. Truly I had not, up to this time, seen anything in rugged nature quite like it.

Here on the crest of this low range of mountains upon which we stood commenting on the sight before us so unusual, Capt. Ewald sat down in the dark shadow of the towering range at our backs as we faced the many-colored cliffs, and at the same moment spoke as follows:

"Now, boys, go on with your tramping, climbing, and sight-seeing and do not be gone over thirty minutes, for we are to leave at seven o'clock for Copernicus; and Prof. Galvan and I will remain right here until you return."

Prof. Monahan then quickly flashing his eyes around at the individual members of the crowd, started off without a moment's delay along a tortuous, dangerous, unbeaten path leading down the long and steep declivity in front of us and at the same moment spoke as follows:

"I am your leader now, boys, so follow me."

All, except Capt. Ewald and Prof. Galvan, still bound together by means of a long, hempen cord promptly followed in file.

Within a few minutes we reached a narrow ledge, or rather a flange-like projection, some three hundred feet down the slope, overhung by a long, craggy brow of the mountain.

Here as we stood on this narrow projecture at a vertical distance of perhaps eight hundred feet above the valley beneath us, but still in plain view of the variegated cliffs, Prof. Monahan began to point out on the steep inclines in front of us, various objects of interest.

He spoke fluently and at the same time in an intelligent way and an entertaining style, as if unmindful of all else besides, while we busied ourselves by attentively listening to every sentence he uttered and by viewing the strange sights in rugged and picturesque nature about us.

Presently Mr. Waite discovered high up on the face of one of the steep slopes a fairly good representation of a human face, and pointed it out. At first it was rather dim and appeared merely as a rough etching on a plain surface. There were the chin, the mouth, the nose, the eyes, the forehead, and all. And truly the human features were in a general way exceedingly good.

After gazing steadily for a few minutes upon the lineaments of this figure I perceived dimly outlined a

body, to which this head with a human face was attached, slowly developing. In another moment every one had discerned the new developments, which caused us to create some little disturbance as we stood in a huddle on the ledge. Then the figure rapidly rose up in high relief and began to take on all the shades of color necessary to develop itself into a perfect whole.

About the time this representation began to take on the relief form, I discovered that the face had slightly changed its expression from that of unconcern to one denoting at least a small degree of displeasure and was looking off in a different direction.

This figure, as stated in a foregoing paragraph, was almost that of a human form, and its color somewhat that of the background upon which it rested. Up to this moment I had thought of and recognized it as being a part of the background; but presently it was clearly manifest that it was foreign to the solid matter upon which it rested.

In the meantime Prof. Brunor, half in earnest and half in jest, said:

"Boys, I'll tell you what that is—it's a Selenite."

And just as he uttered these words, Profs. Thorsen and Purnell exactly at the same moment pointed out, just above it, on the same slope, another figure similar to this one. It, too, appeared at first as a dim etching, but rapidly developed fully into high relief and took on the various shades of the color of that part of the cliff.

The former of the two strange figures that had mysteriously presented themselves developed on a pale-blue background, while the latter rose up on a pale-yellow part of the slope; and these "painted or sculptured similitudes of the products of the imagination," as Prof. Galvan called them, were almost the color of the respec-

tive surfaces upon which they unfolded themselves—the prominence of outline in each case being brought out largely by heavier shadings of their original color.

CHAPTER XXVI

A THREATENED ENCOUNTER WITH SELENITES AT GAS- SENDI—(Continued)

Interest then began to pick up lively, and a rapid and close search, high and low, for more of those marvelous creations was at once begun with great vigor by everyone.

Within five minutes we had jointly located a dozen or more of those wonderful existences scattered here and there on the faces of the cliffs in front of us; and they so much resembled one another, both in form and facial expression, that it was with the greatest difficulty that we were able to point out any distinguishing marks of difference between them.

"Mr. Monahan, you reckon these are real things?" inquired Dick Prouty.

"There is no doubt in my mind, Dick, about their being living entities," replied Prof. Monahan, "but there is some question as to whether they are material or spiritual existences."

Finally Prof. Knowlton suggested that we approach them for the purpose of close inspection. Prof. Monahan at once gave us permission to follow out the proposal.



FIG. 45. TYCHO, LONGOMONTANUS, CLAVIUS, ETC.

The deep, symmetrical vulcanoid with a prominent central cone, located very near the center of the picture is Tycho. The roughly walled valley to the right of and upward from Tycho, with a triple cone off the center of its floor, is Longomontanus. The large walled valley in the upper part of the picture, with five crater pits on its floor is Clavius. The large vulcanoid adjacent to Clavius and almost on the "terminator," or the line of illumination, with its floor wholly within the shadow is Blanchianus.

(Yerkes Observatory.)

Fortunately we readily found an easy path leading down the declivity; and as we drew nearer, hundreds of these mysterious, grotesque objects developed on the faces of the inclines in front of us, across the valley. And like benumbed bees beginning to revive under the influence of the warm rays of a morning sun, they began to move lazily upward on the acclivities to greater heights. At last we got them on a pretty lively move, when it became clearly manifest to all that they were, at least to all appearances, real things of life.

Finally we charged them as rapidly as our strength and the surroundings would allow, but our approach was necessarily slow; and their upward movements on the steeps, which were rapid in comparison with ours, caused them to unfold themselves by thousands.

If in no way molested these strange creatures remained quite still and invisible, because like the chameleon they took on completely the color of the surface upon which they perched or rested for any considerable length of time. When in any way disturbed sufficiently to cause them to shift their positions on the cliffs or to become frightened or angered, they gradually but slowly became perceptible, their delineations appearing dimly first, after which they rapidly developed into relief forms.

These mysterious but intelligent-looking entities were in general appearance somewhat like human beings, but did not possess the same physical proportions.

They had toes, feet, and legs like a chicken, appeared to be about the size and weight of a human being, and stood with their bodies erect. Their necks were long, straight, and slender, their heads large and round, and their eyes, nose, and chin very prominent. They had neither wings nor arms proper, but instead, a kind of

adjunct resembling arms which joined their bodies at their shoulders. These appendages they drew into a coil when in a position of rest, but which they extended when rapidly shifting their positions.

They had no kind of protective tissue, such as hair or nails, on the body or on any parts of the body, to protect them from the extreme cold, but seemed to wear a kind of artificial head-dress, and a scant covering of some sort for the protection of the whole body.

On account of the steepness and the great irregularities of the slopes it was not possible for us with our means of moving about to get near them; and any desperate or unusual attempt on our part to approach them caused them to make their way rapidly to greater altitudes, which they did by running up the acclivities on their toes and beating the air with their rudiments of arms with great speed and force. They took care to keep well their distance at all times, uttered not a sound of any kind, and stared wildly at us like owls. They moved about simultaneously in large, compact squads, appeared to be armed with some sort of artificial weapon of defense, and indicated by their general maneuvers that they would, if pursued too closely, do us violence.

Within thirty minutes after we discovered the first of these strange creations, there were no less than ten thousand of them assembled on the upper cliffs in plain view of us. They did not seem to be able to fly, yet they congregated rapidly; and as we were not able to discover their approach, our final conclusion was that they were all about us in great numbers from the first and that the disturbance we created merely brought them into prominence.

As their number increased, they became somewhat tamer and manifested a decided tendency to set upon us for battle. Prof. Thorsen excitedly drew his revolver and fired several shots at the Selenites at long range, but to no perceptible effect.

But the most mysterious thing that came directly under my observation was the fact that the pop of firearms or a threatened stroke of violence of any kind on our part caused them to explode without report and rapidly disappear in the form of smoke. No sooner would they disappear in this way, than they would reappear in another place not far from their original positions.

Prof. Monahan commanded us not to resort to any means of violence against them, as they might have some means of destroying us instantly in retaliation.

We then retraced our steps to the mountain crest where we left Capt. Ewald and Prof. Galvan and there found them impatiently awaiting our return.

"When we get back," said Prof. Monahan just before we reached the top of the incline, "let Mr. Shipley relate our experiences on this venture."

"You have missed what might have been the most exciting and interesting experience of your lives," said Mr. Shipley after connecting up with Capt. Ewald and Prof. Galvan.

"Well, what is it?" inquired Prof. Galvan.

"We ran into a large colony of Selenites just across the valley—no joke," said Mr. Shipley in reply. "There are ten thousand of them, and every one looks just alike."

"I am fully convinced by the state of things here that the moon is not inhabited," responded Prof. Gal-

van. "What you saw are only the painted or sculptured similitudes of the products of the imagination."

"Imagination—nothing!" exclaimed Mr. Shipley. "We all saw them."

"We saw it all from here," interrupted Capt. Ewald. "Line up now and let us make a hasty retreat to the ship."

One strange thing connected with this pompous display on the stupendous inclines in front of us was that all the prominent members of our company—Capt. Ewald, Dr. Wharton, Profs. Monahan, Galvan, Rider, Purnell, Brunor, Knowlton, and Thorsen—took comparatively no further interest in the matter and gently but persistently refused to enter into any further discussion with any of the rest of us, or to express any opinion, thereafter, concerning this strange exhibition. Every time I asked any question concerning, or made any mention of, this wonderful spectacle on the mountain slopes to any one of the promoters of the expedition, he merely smiled without making reply, and quickly changed the theme.

This ostentatious show on the steep declivities was to me, and is yet, a profound mystery; yet, I sometimes wonder if the whole drama on the cliffs was not a motion-picture effect produced by Capt. Ewald and Prof. Galvan from the mountain crest behind us.

Here are some slight evidences of it: in the first place, the big men did not make strange of our story of the performance, nor did they appear to take any further interest in it; in the second place, Capt. Ewald and Dr. Wharton urged Mr. Shipley off on this special trip while he was still carrying his arm in a swing as a result of injuries received at Tycho, when in my opinion

he ought to have been in bed; and in the third place, Prof. Galvan carried in his hand, on this trip, a large receptacle resembling a suit-case which he said contained twenty pairs of climbing shoes.

In my opinion this large suit-case contained the fixtures for producing a motion-picture show, and that the spectacle we witnessed on the cliffs was an entertainment of this kind given by Capt. Ewald and Prof. Galvan to break the monotony and Mr. Shipley's spell of despondency, and to revive the low-spirited members of our party.

We reached the ship at seven o'clock and without delay sped our flight for Copernicus which is at a distance of seven hundred and ten miles from Gassendi.

We reached destination at half past eight o'clock in the evening, and hovered the ship from the scorching rays of the sun, under a brow of the mountain overlooking the terrace on which stood the biplane.

At this time the sun was getting well up overhead, and his rays were blistering hot and beamed upon us with a degree of intensity that was unbearable.

The floors of the lava seas and the eastern slopes of the hills and the mountains which for the past few days had been exposed steadily and directly to the sun's rays were so intensely hot that it would not have been possible for anyone to stand for one moment upon them with bare feet; while the thermometer, when exposed directly to surfaces and to space that had been lying wholly within the shadows, indicated a degree of cold reaching far below zero.

Finding it reasonably comfortable at this place, under the protection of the massive walls of the ship perched on the terrace in the dark shadows of the

mountain crags, Capt. Ewald directed that we prepare and eat our evening meal, and retire for the "night." The orders were promptly carried out, and by nine o'clock we were in our bunks.

CHAPTER XXVII

FROM COPERNICUS TO GRIMALDI via KEPLER, ARISTARCHUS AND HERODITUS

At seven o'clock on the morning following our return to Copernicus we took our departure from Grimaldi by way of Kepler, Aristarchus, and Heroditus.

As usual the Petrel, familiarly known among the members of our party as Old Trusty, led in the flight; but on account of the extremely high degree of heat at Copernicus at that particular time, caused by the vertical rays of the sun, every one took passage in the ship except aviator Thorsen who alone flew the biplane throughout most of the day.

This was the morning of December 30, the close of the first week of our travels on our satellite. During this time I observed that the moon's surface, everywhere it had come under my observation, is solid rock of the hardest character and of untold depth, with scarcely a dust of soil or the vestige of the signs of life in any form upon it. I discovered also that the valleys everywhere are deep and sharp, the declivities exceedingly steep and rough, and the extremes of heat and cold inconceivably great.

I wondered to what great cause this barren and desolate wilderness owes its existence; and after a little reflection it became manifest that these sterile and deserted regions owe their lone and unfruitful conditions wholly to the absence of an atmosphere of any considerable amount, upon which the natural process of weathering in all its forms wholly depends.

Without an atmosphere enveloping the earth to a great depth there could be neither the sharp and frequent changes in the weather to pulverize the solid rocks, nor the actions of winds and water to transport this powdered substance to the low-lands to deposit it as soil.

In other words, without any air surrounding the earth there could be neither atmospheric agents at work, nor erosion, to which alone the broad and fertile valleys and the wide-extended plains on every grand division on the face of the earth with their teeming millions of stored-up wealth of every form owe their origin and existence.

And directly to these processes of weathering, and indirectly to the atmosphere itself, are due also, largely, the wide distribution of plant and animal life and everything that lends beauty and tenderness to an earthly landscape.

The earth's atmosphere is a great blanket almost two hundred miles thick and covering the entire surface of the earth embracing two hundred millions of square miles.

After an experience of one full week in a world totally barren and with such extremes of protracted heat and cold and with scarcely the vestige of air surrounding it, I was led to see that the atmosphere of the earth is a great reservoir of heat which it, in its various



FIG. 46. MOON'S AGE TWENTY-ONE DAYS.

On this plate is shown the entire route of our long southern tour to Newton.

(Lick Observatory.)



FIG. 47. GASSENDI AND SURROUNDINGS.

The large vulcanoid near the center of the picture is Gassendi. Note the long, deep rifts on the floor of this ring mountain.

(Nasmyth's "Moon.")

movements, economically and at the proper time deals out where it is most needed.

In other words, a little reflection taught me that this great reservoir of heat, in its immense expanse and depth, constantly shifting from colder to warmer regions and vice versa, laden with food and heat for germinating and feeding plants in regions where this would not otherwise be possible is not only the greatest force in distributing heat and tempering climates in every region on earth, but in a true sense the greatest means of transportation in existence.

At forty minutes past nine o'clock, after having traveled a distance of about three hundred and twenty miles, we reached Kepler.

This formation we found to be a deep, circular crater ring somewhat smaller than Eratosthenes and in every way entirely free from deformities. As this structure possessed only one prominent feature that distinguished it from most other relief forms of its class—that of being the center of a ray-system—we continued our flight.

We arrived at Aristarchus and Heroditus at one o'clock p. m. and descended to the surface.

Heroditus is approximately twenty-four miles in diameter and has peaks on the crest of its ring four thousand and five hundred feet high, while Aristarchus is twenty-eight miles across the center and has peaks on its rim whose summits reach an altitude of eight thousand feet above its floor. Both are deep and rugged and lack symmetry, but are truly most interesting objects of study, both in their contour and in all their minor details.

These two great craters are so close together that they almost invade each other, and Aristarchus is the

center of a ray-system. The floor and the inner slopes of this ring mountain form the brightest spot on the visible hemisphere of the moon, and constitute the only area that can be seen from the earth through a telescope, on the night side of our satellite. The surface within the ring is composed of a material that fairly gleams in the sunlight and gives off a phosphorescent light in the dark. This led the great English mathematician and astronomer, Sir William Herschel, to conclude that it was a volcano. This particular distinguishing feature is the peculiar characteristic that led the selenographers and astronomers among our number to visit this point.

A gigantic rent in the surface takes its origin in the wall of Heroditus and angles by several sharp turns in the general direction of north. This tremendous cleft is almost, if not quite, one hundred miles in length, from eight to ten miles in breadth in the widest parts, and so deep that we were unable to see the bottom except in places where it had been partially filled by meteoric bodies and avalanches of stones. For some minutes we stood on the brink of this mighty chasm, peering with curious and wondering eyes into its fearful and awful depths.

Perhaps next to the study of the enormous mountain rings in the points of size, symmetry or the lack of it, relative positions, and above all the study of their origin and their age, that of the great ray-systems which have their centers in Copernicus, Kepler, Tycho, and Aristarchus is the most wonderful and interesting.

These systems in every instance develop under a high sun; and in the cases of Kepler, Aristarchus and Copernicus the streaks of light are developed on a relatively

level surface, while those of Tycho intersect a very rugged surface. (See Fig. 44.)

Under a high sun and a powerful telescope these ray-systems are clearly visible from the earth, and the bands of light radiating from these craters extend for hundreds of miles and give these vulcanoids the appearance of luminous bodies or areas.

But these large craters manifest no such systems at the close range of vision under which we inspected them.

At two o'clock in the afternoon Prof. Galvan handed the aviators, Profs. Thorsen and Knowlton, the bearing or course for Grimaldi, after which the two daring airmen mounted the Petrel and at an altitude of a little more than two miles sped their flight for destination. The craft bearing the rest of the party followed closely in the rear.

After a straight and continuous flight of eight hours and twenty minutes, above the moderately smooth and gently-rolling floor of the Mare Procelerum or the Sea of Tempests, and after traveling a distance of about one thousand miles, we reached Grimaldi, a giant ring plain equal in the points of magnitudes to Clavius and Shickard.

There was nothing of an awe-inspiring nature about this great natural structure, because its ring was beyond the sweep of our vision as we stood near the center of its floor. The surface of the inclosed plain is as black as rubberoid and as hard as cinder, and bears the distinction of being the darkest of all the areas on the face of the moon.

It was late in the evening when we arrived at destination, and everybody was weary with the rapidly-

changing scenes and experiences in general, of the day ;
and for this reason, more than for any other, we at once
ate our evening meal and retired for sleep and repose.

CHAPTER XXVIII

FROM GRIMALDI TO PETAVIA via PALUS SOMNII, LANGRENUS AND VENDELINUS

We left Grimaldi at seven o'clock on the morning of December 31. At five o'clock in the afternoon of this same day we passed beyond the "limb" of the moon; and the earth, which had up to this time been pursuing a jerky course across the sky in strict harmony with our ship's zigzag direction near the surface, but in an opposite course at every angle or turn, disappeared behind the eastern horizon.

At six o'clock on this same afternoon we descended to the surface and found ourselves wholly within the invisible hemisphere of the moon. We were then truly strangers in a strange land, a region which no human foot had ever trod nor human eye had ever surveyed or scanned.

As we had neither maps nor photographs of the moon's invisible hemisphere with the bearings of the compass to guide us to objects of interest and study, those in authority advised and urged that the biplane be separated into its component parts and packed in the chests in the ship. The object of Capt. Ewald and the selenographers in urging that the rest of the tour

be made in the craft was to be in a position to descend at any point on the surface at a moment's notice, or to rise above the most defiant highlands in case the need at any time should demand it.

For the next two weeks we pursued a course almost due west, traveling uniformly about two hundred and fifty miles each day, and exploring on foot the remainder of the time in the vicinity of the craft.

At seven o'clock p. m. on January 14, 1915, we saw the earth rise in the west. This phenomenon was the unmistakable evidence that we were again entering the moon's visible hemisphere and that we had completed about three-fourths of our tour.

During the two weeks prior to this date we traveled approximately three thousand miles, or nearly half the moon's circumference; and from first to last, we had had an excellent general view, from our elevated position, of a zone at least a hundred miles in breadth, and discovered that the area in general beyond the extreme field revealed by the moon's librations possesses every type of structure found on the visible hemisphere,—craterlets and vulcanoids, ring plains and lava seas, honey-comb regions and clumsy relief forms, enormous rents and inconceivable altitudes.

About eleven o'clock a. m. on January 15, while the ship was gently soaring at an altitude of about seven miles, Capt. Ewald descried in the distance ahead what appeared to me to be a long, straight, defiant range of mountains extending directly across our path.

On our nearer approach this mighty range proved to be the encircling ramparts of Mare Crisium, or the Sea of Crises, the largest and most conspicuous of all the completely inclosed dark plains upon the face of the moon.

In shape this great ring plain is almost that of an elongated ellipse. It has a minor axis of two hundred and eighty miles, a major axis of three hundred and fifty miles, and an area of seventy-eight thousand square miles. The wall on the southwestern side has a mountainous promontory eleven thousand feet high, and the whole area of the inclosed plain has a gray tint mixed with a tinge of green.

Just at twelve o'clock, noon, the craft came to a position of rest on the topmost part of the tremendous mountain ring. Here for about one hour Capt. Ewald and others were attentively engaged at looking over and studying the photographs and maps of the moon with a view to determining the course to Palus Somnii and Proclus. In due time the bearing was announced, after which we pursued the direction, which corresponded very closely with the transverse diameter of the plain.

At two o'clock, after a steady flight of one hour, we reached Proclus. This is a comparatively small structure, is located exactly in the corner of Palus Somnii, and almost invades the west wall of Mare Crisium. (See Fig. 24.)

The rim and the floor of this little crater, with the one exception of those of Aristarchus, constitute the most brilliant spot on the moon's visible hemisphere. When the sun strikes this crater-plain fairly, it gleams with brilliance; and in other respects, also, it is a most remarkable projecture of the ring-mountain type.

"I have always had a peculiar interest in inspecting this particular object of interest and study," said Prof. Galvan. "I have observed it hundreds of times through a forty-inch telescope and under a high angle of illumination, and each time it appeared almost snow-white."

Paulus Somnii is an extensive diamond shaped region covering perhaps fifty thousand square miles and lying just west of Mare Crisium and close against the northern border of Mare Tranquilitatis, or the Sea of Tranquility. Its bounding lines are sharply defined and the area they inclose is of a light-brown color and covered entirely with short, flat, parallel ridges.

The floor of the great, adjacent sea is, in color, a dark-gray and contains an endless variety of small and varied details.

At this point quite a heated dispute arose among the prominent men of our party as to the next general course to be pursued.

Prof. Galvan was at this time in a rather critical condition. His face was swollen as if he had been violently attacked by a case of erysipelas and his eyes were almost closed. For the past eighteen hours he had been confined to his bunk. At this place he was up only a few minutes, by Dr. Wharton's consent—just long enough to take a general view of Proclus, Palus Somnii, and surroundings.

Mr. Shipley was threatened with blood-poisoning, due to injuries received at Tycho about two weeks prior to this time.

For the foregoing reasons most of our number expressed a desire to continue a straight westward course and complete the tour of the moon as quickly as possible and depart for home; while others, including Capt. Ewald, Prof. Monahan, and Dr. Wharton insisted on going a zigzag southern route by way of Langrenus, Vendelinus, Petavia and Fernurius, four giant ring mountains arranged in lineal order along one of the moon's meridians.



FIG. 48. RAY SYSTEMS ABOUT TYCHO, COPERNICUS,
KEPLER AND ARISTARCHUS.

Although owing to the high sun and the consequent absence of shadows, these vulcanoids hardly appear as elevations, they are, under favorable conditions of illumination, perhaps the noblest objects on the moon.

(Yerkes Observatory.)

After much heated controversy the southern route was agreed upon.

At three o'clock in the afternoon we left Proclus and Palus Somnii, and after a straight and continuous trip of two hours, above the moderately-rolling floor of Mare Foecunditatis or the Sea of Fecundity we reached Langrenus, a large and beautifully-shaped ring mountain lying about seven hundred miles almost due south of Mare Crisium.

This structure is ninety miles in diameter, and its bulwarks or rim is almost uniformly ten thousand feet high. On the crest of its rim there are a number of tall peaks; and a cluster of rugged mountains shooting upward to an altitude of three thousand feet marks the center of its floor.

We did not descend to the surface at this place, but had an excellent bird's-eye view of this wonderful formation, at short range, and ample time while passing over it to inspect in a general way its great variety of details.

Almost by the time the walls of Langrenus disappeared in the distance behind us, the rim of Vendelinus, in front of us, merged into view. This eminence we readily recognized by the two small craters which invade its ring.

The sun at this time struck its breached walls in such manner as to bring into prominence the ridges, the precipices and the rugged peaks of which its very irregular ring is composed, by contrast with the deep shadows, and made it a more awe-inspiring sight than any one can possibly imagine.

Here we descended to the surface and remained one hour.

This great ring plain contains a very strange feature not found about any other class of formations on the face of the moon. This peculiar characteristic is an extensive valley whose floor is punctured, like a sieve, full of holes. These frightful apertures are from two hundred to seven hundred feet across, and so deep that the huge stones which we rolled into many of them often awakened no echo.

At eight o'clock p. m. we arrived at Petavia, a walled valley, with a conspicuous mountain group rising at its center, lying due south of Vendelinus. But the distinguishing characteristic about this natural wonder is the extreme convexity of its floor. This inclosed area is eight hundred feet higher at the base of the central mountain group than at its edges along the base of the inclosing mountain ring.

Owing to the unimproved condition of Prof. Galvan, Dr. Wharton advised that we remain over a few hours at Petavia, which admonition was followed out.

CHAPTER XXIX

DEATH OF PROF. GALVAN AT PIC-CO-LOM-I-NI

At one o'clock on the morning following our arrival at Petavia Prof. Galvan fell into a state of unconsciousness from which he never fully revived.

At this time his eyes were completely closed, his pulse was weak and unsteady, and his breathing shallow and difficult. Twice between the hours of one o'clock and six o'clock of this same morning he revived to a semi-conscious state, but appeared to have lost all interest in the great work he had undertaken for the benefit of science and to know or to care nothing about our location and our progress in any way.

When in a perfect state of health he was exceedingly strong, both physically and mentally, and the most energetic, enthusiastic, and tireless explorer and seeker after facts and truth I ever knew.

At thirty minutes past nine o'clock he regained consciousness, to the great and pleasant surprise of all, and called Capt. Ewald's private secretary to his bedside.

"Mr. Shipley, please preserve all my scientific notes, which I have had you record, in your own care," spoke he, "and when you return to earth again, place the mat-

ter into the hands of Capt. Ewald and Prof. Monahan."

"I will follow out your instruction," replied Mr. Shipley, "in every detail."

After the lapse of about two minutes more, during which time every one remained silent, Prof. Galvan feebly addressed all present; but as his voice was weak and his articulation indistinct, I understood only the last sentence he uttered, with any degree of certainty.

"Friends, I regret very much that I am not able to look upon and enjoy the sublime and wonderful aspects of nature that throng your pathway at every move," he said, "yet after all the greatest venture of this life and the most sublime thing of which I can conceive is to die."

Immediately after the close of this utterance he again collapsed into a state of total unconsciousness.

Dr. Wharton gave it as his opinion that the tremors and the constant tilting of the ship, which were often violent in rapid flights through the atmosphere, were making somewhat against his patient's well-doing, and advised and urged that we remain indefinitely at Petavia—until there was a change in his condition for the better.

Capt. Ewald, when he found that we were likely to be delayed for a considerable length of time at this point, merely stated that those of us who so desired might, if Prof. Galvan's condition improved a little, pass time both pleasantly and profitably by making short side-trips from this stop, in the biplane.

Fortunately at ten o'clock Prof. Galvan was much better and resting quietly. Then the biplane was brought out and Prof. Purnell and the aviators set it up; and by twelve o'clock, noon, everything was in readiness for a venture on a side-trip.

Not many seemed very much inclined to want to go out on this occasion; but finally Messrs. Waite and Vanderlip, the Rev. Mr. Merritt, Prof. Brunor, and the writer mounted the Petrel with Aviator Thorsen, and a flying trip was made to Fernurius, a ring mountain of about the magnitude of Vendelinus, lying two hundred miles south of Petavia.

To our great disappointment we looked for and expected something new along the way in the aspect of nature—something out of the ordinary.

At two o'clock p. m. we arrived at Fernurius; and as this structure possessed no interesting features to distinguish it entirely from other projectures of its class, we were not wholly pleased with this side-trip.

We found this elevation to be a large ring mountain with a number of towering peaks along the crest of the south wall, and with the north wall breached or invaded by a small lava-sea—demolished almost to the level of the general surface for at least forty miles in its length.

The biplane passed easily over the low ruins of the ramparts and we continued our course around the floor and close against the rim of the mountain.

We were almost one hour in making the circuit. We did not descend to the surface at any point within the mountain's ring, and on our return trip passed out above the breach in the wall and continued our course in the direction of Petavia where the ship was moored.

After a continuous trip of about five hours we reached the ship at forty minutes past four o'clock in the afternoon.

At six o'clock a. m. on the following day, Jan. 17, after a stay of thirty-six hours at Petavia, Dr. Wharton stated that in his opinion Prof. Galvan could not

recover, and advised that as the sun was encroaching on us we might gently pursue our westward course.

Accordingly at seven o'clock our ship rose to an altitude that placed us safely beyond the towering reliefs and slowly floated away at about one-third the limit of its speed, or at the rate of one hundred and twenty miles an hour, in the direction of the Altai Mountains.

Early in the afternoon we arrived at Piccolomini, a large, rough, symmetrical vulcanoid more than one hundred and fifty miles in circumference, located in a wild region which marks the southeastern extremity of the Altai range. (See Fig. 52.)

The approach to Piccolomini was grand beyond description. From an altitude of five miles above the towering peaks the whole region about us seemed to consist of endless and countless parallel ranges of mountains, which resembled, very much, stupendous breakers at sea moving at high angles to a horizontal plain and charging one another in their mad rage in the time of a furious storm.

The ranges from crest to crest are about two miles apart and the floors of the gorge-like valleys lying between them are from one and a half to two miles deep, from two hundred and fifty to seven hundred feet broad, and covered to considerable depth by meteoric bodies and avalanches of stones.

The acclivities on either side of the valleys are almost vertical and the faces of the cliffs as far upward as the eye can reach are covered everywhere with long, protruding tongues of hardened lava which reminded me of furnace slag full of holes and covered with blisters.

At three o'clock on the morning of Jan. 18, Prof. Galvan, the scholarly and talented young scientist

whose researches during his explorations among the lunar mountains will doubtless be a valuable addition to science, passed peacefully away to the great unknown.

And it was on the floor of one of those gorge-like valleys, in the black shadows of the mountains of this wild and forsaken district lying just outside the north wall of Piccolomini, that this young Irish genius, surrounded by all the rest of the members of our party, breathed his last.

At eleven o'clock in the morning we laid away his mortal remains. The surface of the moon everywhere in valley and on mountain top is solid rock of the hardest character. We knew that to dig a grave within any reasonable length of time, with the simple tools we had at hand, would be almost next to impossible; therefore after a brief consideration it was agreed that we would, if possible, find in the vicinity of the place in which our distinguished friend and associate departed this life a natural sepulcher in the face of a cliff and near the level of the valley, and there, after appropriate ceremonies, place his mortal remains.

Finally we found not far away a shelving rock protruding from a steep incline underneath the projecting brow of the mountain. Upon this we placed the bedding taken from his berth in the ship; and after a brief and simple, but appropriate, funeral service conducted by the Rev. Mr. Merritt, the boy preacher, we placed thereon his body robed for the "grave" in his arctic suit, and spread over it his two heavy comforts.

After the burial rites had been performed we slowly ascended in the ship to the gentler slopes of the mountain wall near the crest. Here throughout the remainder of the day Profs. Monahan, Brunor, and Pur-

nell were engaged at painting on one of the incline a large cross to mark the last resting place of the mortal remains of the deceased.

Dr. Wharton attributed Prof. Galvan's death to over exertion while exploring mountainous regions, and to the unequal pressure of the atmosphere enveloping the moon and that pent up in the cavities of the body.

In fact, this was the most difficult physical condition we all had to withstand—the drawn-out state of the moon's atmosphere—and every one suffered severely from this natural state of the elements.

After the loss of this respected member of our company the intense interest in exploration, sight-seeing, and the study of lunar topography began to wane. It was clearly manifest now that in the hearts of all there was a longing for home. From this time on until the tour of the moon was completed, we continued to move along each day on our journey with the advancing sunlight, but made practically no more effort to increase our store of scientific knowledge.

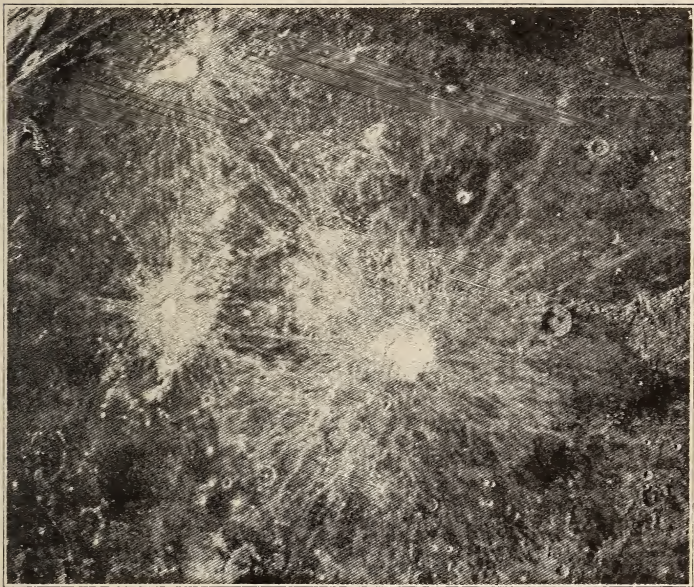


FIG. 49. ENLARGED VIEW OF THE RAY SYSTEMS ABOUT COPERNICUS, KEPLER AND ARISTARCHUS.

The most important features here exhibited are the systems of bright rays of Copernicus, Kepler and Aristarchus. These three ray systems, though less extensive than that of Tycho, taken together constitute the greatest exhibition of the bright bands that exist on the face of the moon. (See Figs. 44 and 48.)
(Yerkes Observatory.)



FIG. 50. MARE CRISIUM AND NEIGHBORING PARTS.

The roughly circular area with a dark floor, at the left margin of the picture is Mare Crisium, or the Sea of Crises. The small bright crater pit on the inner slope of this ring plain is Proclus. The diamond-shaped district just outside the wall of Mare Crisium and to the right of proclus is Palus Somnii. Upward from Mare Crisium, and arranged in linear order along the left margin of the picture are four large vulcanoids, Langrenus, Vendelinus, Petavius and Fernurius. Piccolonini is faintly visible in the extreme upper part of the picture and marks the most southern point we reached in this field of view. The large vulcanoid at the sharp angle near the point at which we pass out of the field is Theophilus. (See Fig. 52.)

(Lick Observatory.)



FIG. 51. A LANDSCAPE VIEW OF THE DISTRICT JUST
OUTSIDE THE NORTH WALL OF PICCOLOMINI.
(IDEAL.)

It was here in this grewsome region that Prof. Galvin departed this life. The large, black cross on the acclivity at the right faces the gorge-like valley in which rest the remains of this scholarly young Irishman. (See Fig. 52.)

(Nasmyth's "Moon.")

CHAPTER XXX

FROM PICCOLOMINI TO THE HYGINUS CLEFTS via CATHERINA, CYRILLUS AND THEOPHILUS

At five o'clock on the morning of Jan. 19, we took our mournful flight for the Hyginus Clefts by way of Catherina, Cyrillus, and Theophilus.

For about half the distance that separates Piccolomini from Theophilus we followed pretty closely the thread-line of the great valley lying just east of the escarpment of the long, curved range of the Altai Mountains; and for the remainder of the distance we pursued an air line, or a direct course.

And our ship just moved along at less than one-third the limit of its speed throughout almost the whole of the forenoon.

Between the hours of ten o'clock and twelve o'clock we were passing across the floors of Catherina and of Cyrillus; and exactly at twelve o'clock, noon, we came suddenly upon Theophilus, the monarch of all lunar ring mountains.

Our ship came to a position of rest on a narrow terrace so near the top of its ring that a climb of thirty minutes brought us to the bases of the peaks that crown the crest.

Catherina and Cyrillus are each about two hundred miles in circumference. They are roughly circular but symmetrical, and have rather squatty ramparts but well-defined outlines. They have comparatively gentle slopes and shallow floors; and, when viewed from an altitude of ten or fifteen miles, exhibit a ruined and ancient appearance.

Theophilus, on the contrary, is in the shape of an elongated ellipse, is sixty-four miles in transverse diameter, and has an altitude of eighteen thousand feet. It is strongly ridged all round and has a central mountain mass composed of several sharp, rough, irregular peaks, which covers three hundred square miles and rises abruptly to an altitude of six thousand feet above the floor of the tremendous basin in which it stands. The encircling rampart is divided by concentric, segmental, terraced ridges which present every appearance of being enormous land-slips resulting from the crushing of their overloaded summits, which have slid down in vast segments and scattered their debris upon the surrounding plateaus and upon the floor.

I observed also many radial ridges or spurs leading away from the exterior slope of the wall. These I easily traced finning away for fully a hundred miles in a number of directions until they became such delicate objects as to approach invisibility.

This giant ring mountain invades Cyrillus and appears as new and as fresh as if it had just been turned out of the mould, which are, within themselves, competent evidence that it is of much more recent formation than either of the other two large vulcanoids with which it is intimately associated.

When viewed from a great altitude, the three large crater rings roughly and briefly described in this con-

nection are seen to have relative positions that give them the appearance of the "Odd Fellows' Links"; and it was by this name that Prof. Monahan always thereafter designated this particular group of formations.

As we stood lined-up on the crest of this wonderful structure and gazing downward into the great bowl-shaped depression that the ring incloses and upward at the towering summits adorning the crest, I could not imagine a more stupendous and interesting excursion for a mountaineer, a geologist, or a seeker after wonderful and sublime aspects of nature than a climb about the walls of Theophilus.

At two o'clock, after enjoying some of the most wonderful sights in rugged and picturesque nature, and a delightful and refreshing repast served on the crest of Theophilus, we pursued a direct line for the Hyginus Clefts.

The late photographs of the moon which we had with us clearly indicated that the region we were to pass over in this part of the flight was rich in grand scenery and instructive objects; but I had lost so much sleep during Prof. Galvan's illness that I could not stay awake to survey this wonderful district, and retired to my berth for sleep and repose.

I evidently fell at once into a deep sleep, for the next thing I knew Prof. Rider pulled me half out of my bunk and at the same moment yelled out:

"Get up, we are at Hyginus. I have just been out to see the mighty cleft; and truly I wish I had not seen it, for I fancy it resembles the gateway to perdition."

"How far are we from Theophilus?" inquired I, discovering from a clock across the room that I had been asleep two hours and forty minutes.

"Four hundred and eighty miles," responded Prof. Rider, as he hurriedly made his exit from the sitting room.

Within a few minutes I was up, dressed, and in every way fully equipped for a tramp and sight-seeing.

While I was dressing and equipping myself to go out, not a soul was inside the ship; and when I passed to the outside, I saw the rest of the company lined up on the brink of the mighty chasm about seventy yards away.

In another minute I was present with them and peering with great astonishment into this mighty schism which extended both to our left and to our right, far beyond our ken of vision, and whose broad expanse was indicated by the summits of the foothills on its farther brink, clothed in the mellow light of the full earth.

We were not able to see any distance into the appalling depths of this tremendous rent, because the dark shadows cast into it by a low sun gave it the appearance of being brim full of smoke as dense and as black as was ever puffed from the stack of a locomotive or a steam vessel.

At the time of our arrival at Hyginus the sun was not sufficiently high up in the sky to illumine this great chasm, and for this reason Capt. Ewald and Prof. Monahan insisted on remaining at this place indefinitely in order to view it under a high angle of the sun's illumination.

Hyginus itself is just a little structure of the ring mountain type, not more than twenty miles in diameter, but is remarkable for being cleft through the center by this enormous rent which is almost two hundred miles in extreme length, from seven to ten miles

in breadth, and from nine thousand to thirteen thousand feet deep.

There are two arms of this enormous split in the surface, both of which take their rise in Hyginus, and for this reason it is spoken of as the **Hyginus Clefts**. One arm extends from east to west, and the other from northwest to southeast. (See Fig. 54.)

Fortunately we were not compelled to remain long at this point. On the morning following our arrival at this place the sun peeping over the low ranges of the hills in the distance shone almost directly into the end of the eastern arm of the rift and illumined the south wall for many miles of its length and for untold fathoms down.

Our ship then descended into this great fissure to its greatest depths. In some places the cleft is partially filled with huge stones, while in other places there has been no disturbances whatever in the nature of avalanches. The floor of this mighty chasm, where it is exposed, is uniformly about one thousand feet in breadth; and in some places, where it is bare, it is severely troughing or concave, while at other points it is convex.

From our position at the bottom of the rent Messrs. Waite and Vanderlip made photographs which show perfectly both walls of the fissure.

Prof. Monahan and Capt. Ewald, after closely inspecting this huge rent, said that originally it was much deeper than it is now, and that either immediately, or very early, after the sudden formation of the rift, the lava rose and finally, after ages of cooling, consolidated into rock.

This cleft is by far the most magnificent thing of its class that we found on the face of the moon.

CHAPTER XXXI

FROM THE HYGINUS CLEFTS TO ARCHEMIDES via BESSEL, LINNE AND THE HAEMUS MOUNTAINS

At nine o'clock on the morning following our arrival at the Clefts, we pursued the course for Archemides by way of the Haemus Mountains, Bessel, and the problematical Linne.

We first took the direct route for the Haemus Mountains, a rugged, picturesque high-land system lying two hundred and ninety miles northeast of Hyginus, and forming a part of the abrupt southern border of Mare Serenitatis, or the Sea of Serenity.

In the point of grandeur, or magnificence, this system of high-lands is really below medium, but is distinguished for having near the center of its greatest elevation a beautiful vulcanoid about thirty miles in diameter, with a floor almost as white as chalk.

This mountain, called Menelaus, slightly invades the adjacent sea; and, when seen from the earth through a powerful telescope and under a vertical sun, it is a conspicuous crater and shines like a precious gem.

We did not come to the surface at any point in the Haemus Mountains, but continued our course almost

straight ahead at a moderate elevation above the floor of Mare Serenitatis.

At half past eleven o'clock, one hundred and twenty miles from Menelaus, out upon the smooth, extensive lava sea we passed Bessel, a beautiful, solitary crater ring fourteen miles in diameter and about seven thousand feet deep. Bessel is as perfect in shape as a big China wash-bowl, has steep, smooth slopes, and is surrounded on all sides for many miles around by the dark, smooth surface of the Serene Sea.

At this point we angled severely and pursued the course pointing almost due west; and at one o'clock p. m. we descended to the surface one hundred and fifty miles from Bessel, at the site of the problematical Linne.

Perhaps the reader would be interested to know that Linne is a point on the floor of the Sea of Serenity, which in the earlier part of the nineteenth century was clearly recognized by astronomers as a well-defined crater ring seven miles in diameter and one thousand feet deep, and that in the year 1866 it suddenly disappeared and has not been seen since except as a faint, diffused spot on the dark background of the sea floor.

When viewed from the earth through a forty-inch, reflecting telescope, it had, since the year named above, resembled somewhat a great fire light; and for this reason some eminent astronomers believed the miniature vulcanoid had been totally destroyed by a tremendous eruption.

This was one of the points on the moon's surface in which every one's interest had been centered, even before we took our departure from the earth; but it had not, as yet, appeared to any of us that our approach to this object of intense concern was so near.

Just as we were leaving Bessel, Prof. Monahan began to relate the history of the structure under consideration; and at the conclusion, when he informed us that we would reach Linne within one hour and that this point would be our next stop, we could scarcely believe our ears.

As we steadily approached this spot, naturally all eyes were on the look-out for a seething lake of fire; but instead, the place proved to be a very bright area of moderate elevation with a rough detail and a number of ragged peaks reaching an altitude of from five hundred to a thousand feet and covering something over two hundred square miles.

As we drew near this point I truly entertained grave fears that we would really find it to be a lake of unquenchable fire, and keenly felt the sting of disappointment when we found it different.

This little region we found to be as "cold as an iceberg," and it was clear to be seen that it had not in any degree been disturbed by the agency of heat for untold thousands of years or even for ages.

The selenographers spent the whole of the afternoon in carefully examining this district, but the close inspection they gave it revealed nothing out of the ordinary.

At eight o'clock on the following morning we departed from Linne and pursued the course leading directly through the strait that connects Mare Serenitatis with the Imbrium Sea.

After traveling in a direct line about one hundred and sixty miles and passing through the strait, we were confronted by the wall of a large vulcanoid which some of our party recognized as being a structure which we passed in our flight from Plato to Archemides on Dec.



FIG. 52. CRATER REGION ABOUT THEOPHILUS.

The large, sharply-defined vulcanoid with a prominent mountain mass at the center of its floor, located in the lower part of the plate and near the margin of the illumination is Theophilus. The large vulcanoid in the upper left-hand corner of the plate with its floor in the shadow is Piccolomini. (See Figs. 50 and 51.). The highland system extending in a gentle curve downward and to the right from Piccolomini is the Altai Mountains.

(Yerkes Observatory.)



FIG. 53. THE HYGINUS CLEFT.

(Moreux's "A Day in the Moon," The Frederick A. Stokes Co., N. Y., Publishers.)

27, the day before we began the tour of the moon. (See Fig. 35.) From this point we pursued an air-line extending in a direction almost due southwest, for one hundred and thirty miles to the point where our ship was first moored, and thereby completed the tour of the moon.

During the four weeks we were "circumnavigating" our satellite, we kept close on the heels of night—that is to say near the "terminator" or sun-rise line which separates the darkened hemisphere from the lighted one—in order to escape both the blistering rays of a noonday sun and the intense cold of the lunar night, and yet have the light of day by which to travel and to explore. Besides, the long, black shadows of the stupendous mountain masses cast by a low sun added an awful grandeur to the rugged and wild scenery constantly about us on all sides, which the learned men admired.

At this time none of us felt natural, nor did we look natural. All complained that nothing tasted right and that sleep, such as we were able to secure, was not refreshing.

Every one's face was spotted and rough, and appeared as though it had been severely blistered in a hot flame and was peeling off, and our hair was as dry and lifeless as shredded shucks.

Our flesh over the entire body was slightly swollen, and there was a stiffness in our joints, which made us awkward and clumsy at getting about.

And we all admitted that this great tour had paid us well, but were extremely anxious to depart from this barren and forsaken world and to fly to our earthly paradise.

CHAPTER XXXII

REVIEW OF SALIENT FEATURES

During the tour of our satellite I observed that the main objects of general interest relating to the moon's topography naturally fall into one of the three following classes: first, the great high-land systems proper; secondly, the completely inclosed areas, together with their encircling ramparts, including the ring plains, the walled valleys, and the vulcanoids; and thirdly, the most extensive of the smooth areas with irregular and broken borders, or the great lava seas.

On our tour there came under our observation comparatively but a small part of the moon's surface, yet a sufficiently large per cent of it to warrant the writer in saying that there are pretty regularly distributed over her entire area no less than fifty reliefs worthy of the name **mountain system**.

Among the greatest of the high-land systems found on the visible hemisphere, that came directly under our observation, are the Alps, the Caucasus, and the Apennines.

There are also extensive honey-comb regions, often embracing thousands of square miles, either intermingled with the other various characters of the great relief forms, or in some other way intimately associated

with them. In some places the districts of this particular class seem to form the main plateaus, or the basilar parts of the mountain masses, from which rise the towering peaks. And these needles stand forth bare, gaunt, and dreary, sometimes in roughly conical shape but more frequently in pyramidal form, and under the rays of a low sun present a desolate and forsaken appearance.

Careful observations and estimates during our travels show that beyond doubt there are on the moon's surface no less than forty peaks whose altitudes range from fifteen thousand to twenty-six thousand feet, and that the average angle of the inclines of the lunar projectures of every character is about fifty-two degrees.

The lowest areas are about ten thousand feet below the level of the seas, which makes the moon's total relief approximately thirty-six thousand feet.

Owing to the difficulties under which the selenographers had to work, there were too many doubtful elements in the computations to make the reckonings wholly trust-worthy for absolute accuracy; but in spite of the disadvantages that presented themselves at the times the estimates were being made, the observations and the mathematical calculations unquestionably approach a very close approximation.

Perhaps the most wonderful and interesting of all the lunar structures are those of the ring mountain type, embracing the ring plains, the walled valleys and the vulcanoids proper.

In diameter these structures range from only a few feet to three hundred and fifty miles and are found in countless numbers on almost every part of the moon's rugged districts.

Most of those areas inclosed by ramparts are circular, or with only moderate distortions of this outline, some are irregular in their contour, and a few are in the shape of a half-moon; and the last-named sub-class of structures, which are characterized by the breached walls, invariably have their deformed sides turned toward or facing the open seas or their embayments.

The largest of this class of structures called ring plains, walled valleys, and vulcanoids or ring mountains, are more numerous in, and adjacent to the rugged districts; while the smaller structures of this type, which are almost perfectly circular, symmetrical, and smooth, are found principally in the extensive, level districts, such as the floors of the ring mountains, the sea floors, and the large embayments of the seas.

Nearly all the great projectures of this class are, I observed, arranged in linear order along the general course of the moon's meridians and show pretty generally a tendency to "spooning," or to elongation of the crater, in a general north-and-south direction. The smaller structures too belonging to this class have in many instances a linear arrangement, and I took notice that the linear order of those craters less than a mile in diameter is so common that the exceptions are to be found in the departures from it. Countless chains of craterlets extend from fifty to one hundred miles in length, whose links are jammed so closely together that their rims invade one another and thus form crater valleys.

Regardless of size the lunar structures of this general class possess the following common characteristics: first, they are bounded either wholly or in part by ramparts in the form of steep ridges whose crests are crowned partially at least, with tall, steep, needles

either in conical or pyramidal form; secondly, the inner slopes of their walls are steeper than their exterior slopes; thirdly, the inclosed areas in almost every instance are lower than the general level of the surrounding district; and fourthly, every structure has either a cone or a rugged mass rising at or near the center of its floor, or instead, a cone-shaped pit or cavity.

The following differences, as we pass downward from the largest to the smallest are to be noted: first, there is a progressive increase in the symmetry and freshness of finish of these structures; and secondly, the walls are less breached, and the slopes of their encircling ramparts are steeper and more even.

The largest completely inclosed ring plain that came directly under our observation is Mare Crisium, or the Sea of Crises; the greatest walled valley we visited is Clavius; the most perfectly-shaped craters we saw are Tycho and Bessel; the deepest structure of the ring mountain type is Newton; the most awe-inspiring, or those that possess a solitary grandeur that belongs to no other vulcanoid, are Theophilus, Copernicus, and Piccolomini; and the brightest spot on the face of the moon is the floor of the vulcanoid, Aristarchus, while the darkest spot is the floor of the great ring plain, Grimaldi.

It is scarcely possible for one to form anything like a true conception of the real magnitude of one of those stupendous lunar craters without viewing it from the crest of its ring, from the summit of one of the peaks upon its crest, or from a biplane making a flight around its floor.

Kilauea and Mauna Loa, on the island of Hawaii, each of which has a diameter of about two and a half

miles, are the two greatest known terrestrial craters. And in spite of the magnitudes of these tremendous apertures, they dwarf to insignificance when compared with a favorable view of the Grand Canyon of the Colorado; yet such a part of this wonderful canyon as comes within the range of one's vision as he stands on a brow of this mighty chasm is a mere pigmy or even a Lilliputian by the side of one of the great craters of the moon.

There are on the surface of the moon perhaps not less than forty extensive areas called either seas or embayments of seas. Those dry, hard, lava plains often embrace hundreds of thousands of square miles of surface, and contain within their borders no objects of prominence except here an isolated mesa, there a solitary peak, and yonder a long, squatty, serpentine chain of hills cleft in many places at high angles by mighty rents. These so-called seas are generally very irregular in shape, gently rolling like many of our prairies, and bordered by endless chains of fire-scarred cliffs.

The atmosphere enveloping the moon is so highly attenuated that it is insufficient to support even the trace of a cloud: therefore, there can be no evaporation, no rain, no erosion, nor any weathering of any form in any noticeable degree. As a result the surface everywhere is as dry, flinty, and as clean and pure, chemically, as a brick-kiln; and the mountains everywhere are ragged, lumpy, and tall, and have sharp edges and steep slopes.

And as there is no diffusion of solar light, which is also due to the rarefied or drawn-out state of the air, the shadows of the mountains and of all opaque objects on the moon's surface are absolutely black with clean-

cut edges—the line between the light and shadow being as distinct as though drawn by a ruler. Objects only a few feet away in the shadow are not visible, while even very small objects—objects not larger than a foot-ball—when exposed to the rays of the sun, are distinctly visible at a distance of fifty miles. This distinct vision often caused us to under-estimate greatly the distances to all objects.

The whole surface of the moon bears evidences of having been pounded all over by meteoric bodies which are pretty evenly distributed over the sea floors, but heaped in great profusion against the bases of the cliffs and the mountain ranges adjacent to the seas, and in the gorge-like valleys and the clefts.

The color of the moon's surface varies from that of very bright areas to that which is relatively dark.

The low, level areas, such as the lava seas and the ring plains, are as dark at least as the more somber-hued rocks of the earth's surface, or even as emery stone; while the more elevated regions are almost the color of soft brick. The crests of one or two mountain ranges, the summits of a few peaks, and the floors of half a dozen vulcanoids are, when viewed under a vertical sun, almost of a chalky whiteness; while at least one spot on the moon's surface—the floor of the great ring plain Grimaldi—is almost jet black.

CHAPTER XXXIII

OF OUR TRANS-ETHEREAL FLIGHT FOR EARTH

It is now just twelve o'clock, noon, on Jan. 21, 1915, and Capt. Ewald has just given out the information that at two o'clock we are to take our trans-ethereal flight for earth. Everyone is joyous over the announcement and vigorously moving about getting ready for the perilous flight.

Mr. Shipley is sitting at a table near the center of the room taking dictations, in the form of brief notes, from the writer; Dick Prouty is preparing the last meal to be served on our neighboring little world; Dr. Wharton and Prof. Thorsen are loading on some curios which they have gathered in the vicinity of the ship; Prof. Knowlton is drilling a hole for a small flag staff to mark the place of our arrival at and departure from the moon; Profs. Brunor and Rider are at the condensers compressing air into the chambers in the dome of the ship; Capt. Ewald and Prof. Purnell are installing a fresh storage battery; Prof. Monahan is at the great telescope adjusting the attachments preparatory to taking the spectrum of Alpha Persei; and Messrs. Vanderlip and Waite, and the Rev. Mr. Merritt are about one hundred yards away standing quietly on the brink of a mighty chasm and gazing into its appalling depths.



FIG. 54. THE MARE SERENITATIS AND SURROUNDINGS.

The Hyginus Clefs are near the upper right-hand corner of the plate where we make a sharp angle in our flight. The crater Menelaus is located in the Haemus Mountains at the center of the plate. The beautifully shaped little crater one inch below Menelaus, out upon the floor of the Serene Sea, is Bessel. The faint white spot downward and to the right from Bessel is the site of the problematical Linne. The strait to the right of Linne separating the Caucasus from the Apennines is the Palus Putredinus. The vulcanoid at the right of the strait is Authrolycus. (See Fig. 55.)

(Yerkes Observatory.)



FIG. 55. THE MARE IMBRIUM AND SURROUNDINGS.

(Yerkes Observatory.)

At fifty minutes past one o'clock we hoisted a small United States flag and went on board the ship. The roll was then called and the massive steel door closed, locked and sealed. Exactly at two o'clock we took our departure from that cold, dry, and uninhabited world and pursued our homeward flight.

As the craft sped away through the limitless depths of the trackless and changeless void, Dr. Wharton slowly and solemnly said:

"Henceforth it may truthfully be said that the 'Man in the Moon' is an Irishman; but not, however, the first man that ever broke the Sabbath."

Throughout the time of our transit we were able even by the aid of our small telescopes to follow closely the entire course of our tour across the visible hemisphere of the moon and to locate readily thereon all the prominent reliefs we visited; and for about one week after our departure for home we could by means of the great telescope see the large cross near the crest of the great mountain range just outside the south wall of Piccolomini, which Profs. Monahan, Brunor, and Purnell painted to mark the last resting place of the mortal remains of Prof. Galvan.

The transit from the moon to the earth was in every way equally as perilous as the one from the earth to the moon, and our experiences in general and the scenes constantly about us in the heavens were much the same.

At ten o'clock on the morning of Feb. 19, we entered the aerial region of our native sphere, and forty minutes later quietly descended to the surface near Groton, South Dakota.

The advent of our strange-looking craft and our uncouth and worn-out appearance created quite a sensa-

tion and spread consternation among some young men at a cattle ranch near by, who quickly conveyed the news of our presence to the inhabitants of the village. Within an hour after our arrival nearly every citizen of the town of Groton was at the craft. Although every face was strange to me, I was truly glad to see everybody; and I was equally delighted to breathe once more the atmosphere of earth in its natural state.

Capt. Ewald placed a guard at the ship inside barrier ropes, and then we walked one and a half miles to Groton and took a train for Aberdeen, a good town about twenty-five or thirty miles west of Groton. At this place we bathed, changed our clothing, and got a few square meals at the Sherman Hotel, where we were royally entertained by Mr. J. R. Hubbard, the proprietor.

Early on the following morning, after some hearty, farewell hand-shakes, Capt. Ewald and Prof. Rider, accompanied by Messrs. Waite and Vanderlip, returned to the ship to remain indefinitely. Two hours later Dick Prouty, Mr. Shipley, the Rev. Mr. Merritt and Profs. Thorsen and Brunor left Aberdeen for their several homes in Missouri, Nebraska, Illinois, and Texas. And late in the afternoon of the same day the remnant of our party consisting of Dr. Wharton, Profs. Monahan, Knowlton, Purnell, and the writer took passage on an east-bound train for Chicago, Ill., where we arrived early on the morning of Feb. 23. From this city Profs. Monahan and Purnell at once departed for Philadelphia, Pa., and Prof. Knowlton and Dr. Wharton left about noon on a fast south-bound train for their respective homes in Birmingham, Ala., and Atlanta, Ga., by way of Danville, Ill.; Evansville, Ind., and Nashville, Tenn. The writer accompanied the last-named of these

distinguished men as far south as Madisonville, Ky., where with hearty hand-shakes he bade them adieu. On the following day at ten o'clock a. m. he reached his home at Providence, Ky., a good little town located sixteen miles west of Madisonville, on the Madisonville and Morganfield Branch of the Louisville and Nashville Railroad.

I can scarcely realize now that I have been to the moon. Although I am able to call to mind with distinctness all the principal points of interest we visited and all of our wonderful experiences both of a pleasant and a serious nature, from the time of our departure for the moon until our return to earth, the sum total appears vaguely to my mind as a wonderful dream, or rather as the vision of a world made up of regions or districts of the wildest desolation.

After our departure for the moon, even though I realized we were in every way well and thoroughly equipped, I very much regretted that I had ventured to take this wild flight, because I thought then that I foresaw it was not possible for us to get by the dangers that would from first to last beset us on every side. But since our return to earth, I take an altogether different view of such a situation. With the exception of two perils, the danger arising from the bursting of panes of glass due to the expansive force of the pent-up air and that originating from the presence of star-dust, I truly believe that a voyager making a transit to another world in an ethereal ship constructed and equipped like this one, would be subjected to dangers less grave than he would be if he were making a trans-Atlantic voyage in one of our best-built modern ocean liners.

CHAPTER XXXIV

CONCLUDING SUMMARY

Beyond even the shadow of a doubt in my mind the moon was once a fluid haze of light, and after the lapse of ages she became a great liquid globe whose surface was then a seething ocean of fire.

Our researches during our tour of the moon reveal to us abundantly a world torn and shattered by fearful volcanic action. Her surface has been riven and cracked all over and is everywhere pierced by extinct craters and geysers, whose irregular edges and rents testify to the convulsions our satellite has undergone.

During our travels we crossed quite a large number of valleys with round or troughing floors and varying in breadth from three hundred to seven hundred feet, and in length from twenty to one hundred miles. This particular class of valleys is found only far out upon the lava plains and slightly resembles river beds with gentle fall and gently sloping banks. Countless fragments of meteoric bodies and of small detached stones lying on some of their deeper parts are worn partially round like cobble stones found along the water's edge in river beds. This effect, Prof. Monahan said, is ascribable to no other cause than that of flowing water. It appears to me too that the apparently worn condition of these rocks is evidence sufficient to support the

belief that in the misty past sluices of water flowed gently along the serpentine courses of those valleys; but if these so-called river beds ever transported water along their courses, it had forever been swallowed up into the cavernous regions of the adjacent mountain masses, and into the huge fissures that cleave the valleys and the low and winding chains of hills at high angles to their prevailing directions.

We discovered also here and yonder on the extensive lava seas many comparatively small depressions of moderate depths and a few tremendous basins, which have, pretty generally, irregular outlines. Two of those depressions, we perceived, bear on the lower parts of their steeper slopes coast lines very indistinctly marked and in some respects very much like those found on the lower slopes of the mountains adjacent to the Great Salt Lake, Utah. Those lines often extending great distances on a water level led the selenographers to believe that possibly those depressions were ancient lake beds. The faint coast lines in question led them to think also that vast caverns in the interior, or underground lakes, once communicated freely with the surface lake basins under discussion, by means of fissures and other forms of vents which we observed in the deeper parts of their floors, and that the contents of those lakes might have been swallowed up into those immense receptacles from the great depths of which the sun with his intense heat would be unable to dislodge more than traces of its vapor.

There are still other evidences, it appears to me, that water exists in considerable quantities somewhere on the moon.

At some two or three places we discovered what the scientists among our number declared to be sedimen-

tary and metamorphic rocks, and at one place—in a cavernous region of the Apennine Mountains—a number of giant columns, all of which, in my candid opinion, furnish at least some evidence that their formation and existence are due to the agency of water.

On account of the highly rarefied state of the atmosphere surrounding the moon, it is not possible for evaporation to take place in any noticeable degree, and therefore there can be no rainfall in any form. But this fact does not, it seems to me, exclude the possibility that water exists somewhere on the moon and that ages ago it flowed over parts of the surface; for sluices of water could have been sent coursing along the valleys and over certain parts of the sea floors by means of the agency of internal heat alone.

Some of the members of our company said that it appeared to them very doubtful whether the seas were ever covered by water, or if, since their creation, they ever presented a very different appearance from that which they now exhibit; but truly I believe the presence of water as an active agency on the moon stands revealed in the troughing, serpentine valleys resembling river beds, the presence in places of sedimentary and metamorphic rocks, and the stupendous columns resembling stalactite and stalagmite formations which we found in some of the cavernous structures of the older and more elevated parts of the moon's surface.

At every halt and turn during the tour of our satellite we looked about us eagerly, faithfully, and patiently in full expectation of seeing quadrupeds resembling some of God's four-footed creatures on earth bounding away from us and in search of a hiding place or a place of refuge, but we looked in vain; for in all our travels and researches we found no satisfactory or competent

evidences that anything in the form of vegetable or animal life ever existed there.

Prof. Rider discovered in the solid rock at the mouth of a small cavern some marks which bear a slight resemblance to the tracks of small birds or rodents, and on one lake floor Capt. Ewald and Mr. Waite found small quantities of a loose or detached substance resembling sea weeds drifted, which on close inspection and chemical analysis proved to be merely a rocky substance of a friable nature. A box of chicken bones which Dick Prouty emptied near the ship the day after we reached destination was still there at the end of the thirty days during which we were touring the moon. If animal life as we think of it on earth had existed there, possibly these bones would, in the meantime, have been devoured. But truly I think none of these things are competent or conclusive evidence either way.

We saw no houses nor places of abode of any kind for intelligent beings, no fields nor plantations, no establishments of art and industry. And if ever our satellite was at any time in its past history the seat of all or even a small part of the varied and intense human activities that at the present time characterize the surface of the earth, not the slightest evidence of such ancient civilizations, now remains to bear testimony of the fact.

The physical conditions and the landscape views everywhere make it appear improbable that the moon was ever a world teeming with vegetable and animal life like our own planet, but rather that it was, even in its palmiest days, a desolate wilderness and barren waste.

Even the lowest forms of vitality cannot exist without air, moisture, and a moderate range of tempera-

ture; and on the moon there is neither. It is inconceivable that any plant or animal life could survive exposure, first to a degree of cold vastly surpassing that of our arctic regions, and then in the short time of fourteen days to a degree of heat capable, almost, of melting the less refractory rocks and the more fusible metals—the total range of temperature being equal to perhaps 500° of our thermometric scale. And truly the dry, flinty, barren nature of the surface, the total absence of water, and an atmosphere of so great tenuity, all taken into consideration without the long nights of more than arctic cold and the extremely hot days a fortnight in length, appear to exclude even the possibility of either plant or animal life, at least as we think of it on earth.

In short, the lunar landscape, as it appeared to me everywhere as far as the eye could reach, was a realization of a fearful dream of desolation and lifelessness—not a dream of death, for that implies evidence of pre-existing life; but a vision of a world upon which the light of life had never dawned. In other words, I think of the moon merely as a fossil world, an ancient cinder, a ruined habitation careering through space, and perpetuated only to admonish the earth of her own impending fate and to teach her occupants that another home must be prepared or provided which frost and decay can never invade.

(THE END)





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